Why Do People Seek Information? The Role of Personality Traits and Situation Perception

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The opportunity to learn new knowledge is ever present. How do people decide if information has sufficient value to counteract the cost of obtaining it? We proposed a conceptual model of information seeking that emphasizes how personality traits and perceptions of situations may influence motivations to seek information to *explore* (related to trait curiosity and openness/intellect, and situations evoking more positive emotions and opportunities for intellectual engagement) or *feel safe* (related to trait uncertainty intolerance and neuroticism, and situations that evoke more negative emotions). Across two studies ($N = 436$; $N = 316$), information seeking was assessed with two widely-used paradigms (advance knowledge of a reward outcome and answers to trivia questions), as well as two variations of the trivia paradigm in Study 1. In all contexts, the available information was *non-instrumental*, having no practical utility within the context of the task. Consistent with our proposed exploration pathway, curiosity and openness/intellect predicted the choice to seek information for trivia and related stimuli, but not reward-outcome stimuli, and trivia stimuli were generally rated as more intellectually engaging, more positive, and less negative than reward-outcome stimuli. However, evidence for the safety pathway was only partially in line with predictions, with uncertainty intolerance predicting reward-outcome information seeking in Study 2 only. We consider possible modifications to our initial model and implications for information-seeking research. These studies provide a proof of concept that people display both trait- and context-dependent preferences for non-instrumental information, both of which are commonly overlooked in studies of information seeking.

Keywords Information seeking | Personality traits | Situation perception | Curiosity | Uncertainty intolerance

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Each day brings opportunities to learn new knowledge, but gaining information often comes at a cost of time, effort, or money. How do we decide if information (for example, the weather forecast for the following day) has sufficient value to counteract this cost? Often, the information helps to gain rewards (e.g., learning if a trip to the beach can take place) or avoid punishments (e.g., whether to bring an umbrella to escape a drenching), but there are many circumstances where the information provides no clear benefit to the individual (e.g., looking at the various forecasts in other cities around the world). This latter form of information is commonly called non-instrumental (e.g., Bennett et al., 2016; Eliaz & Schotter, 2010). Why are individuals willing to pay a cost to obtain non-instrumental information? The current research draws on knowledge and theory from personality

psychology to propose a conceptual model of motivations for information seeking. Specifically, we propose that decisions to seek information vary as a function of the degree to which the information-seeking situation affords the possibility of exploration or safety. Further, individuals who tend to be more curious are more likely to see opportunities for exploration, and individuals who tend to be more anxious are more likely to find uncertainty aversive and see opportunities for gaining safety. We present results from two studies that demonstrate the critical importance of the person and the situation for understanding information-seeking behavior.

The Value of Non-Instrumental Information

Information can be defined as data that cause a shift from one's prior to posterior knowledge (Lawrence, 1999)—or, more colloquially, learning something you did

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not know. Why do we seek information? Economists initially proposed that agents seek information that is perceived to provide some net financial benefit (Stigler, 1961; Hirschleifer & Riley, 1979). However, experiments have convincingly demonstrated that people will seek information that provides no such benefit, and many are even willing to pay time, effort, or money to gain non-instrumental information (Bennett et al., 2016, 2020; Charpentier et al., 2018; Eliaz & Schotter, 2010). Further, evidence that non-human animals such as primates (Bromberg-Martin & Hikosaka, 2009; Wang & Hayden, 2019) and starlings (Vasconcelos et al., 2015) assign value to non-instrumental information speaks to the universality of this phenomenon. Understanding the basis of non-instrumental information seeking could provide clues to motivations underlying sub-optimal and counter-intuitive choice behavior (Gilovich et al., 2002), help to understand how primary rewards versus information rewards are computed in the brain (Bromberg-Martin et al., 2010; Bromberg-Martin & Hikosaka, 2009; Gruber et al., 2014; Jepma et al., 2012; Kang et al., 2009; Lau et al., 2020), and aid in uncovering mechanisms that putatively underlie variance in conceptually related personality traits (DeYoung, 2013, 2015).

The fact that people are willing to seek and pay a cost for non-instrumental information, despite limited economic or practical value, suggests it can provide psychological value. One proposed benefit is the resolution of uncertainty (Bennett et al., 2016; Bromberg-Martin & Monosov, 2020; Caplin & Leahy, 2001a; Crupi et al., 2018; Eliaz & Schotter, 2010; Gottlieb et al., 2013; Schwartenbeck et al., 2019; Wu, 1999). Although information does not always reduce uncertainty¹, the two terms tend to map directly to one another—for example, checking the weather before you head outside removes uncertainty you previously had about this state of the world. For advocates of uncertainty-reduction explanations of information seeking, uncertainty is often considered aversive and anxiety-provoking (as it could signal a potential threat lurking in the environment; Carleton et al., 2007; Hirsh et al., 2012), and resolving uncertainty can help to reduce this anticipatory anxiety (Bennett et al., 2020; Caplin & Leahy, 2001b; Wu, 1999). In support of this explanation, computational models based on uncertainty-reduction fit well to participant data, and information seeking has been found to correlate with indices of negative emotionality and anxiety, such as neuroticism and obsessive-compulsive tendencies (Bennett et al., 2020).

Despite the prevalence of this explanation, it seems unlikely that all instances of information seeking can be ascribed to motivations to reduce uncertainty-induced anxiety. Reflecting on your own information

search patterns, do you sometimes seek information simply for the joy of learning something new? If so, then your information seeking may reflect an alternative anticipatory emotion elicited by uncertainty that has been proposed to drive information seeking: curiosity (Gottlieb et al., 2013; Kidd & Hayden, 2015; van Lieshout et al., 2020). Curiosity can be defined as the desire and interest to explore new, uncertain, and/or complex events (Kashdan et al., 2018). As curiosity represents an expansive exploration of the unknown rather than fear of the unknown, it could be said to denote the opposite attitude to uncertainty-related anxiety. Studies assessing the relation between curiosity and information seeking find that participants will pay in time or money to seek information for stimuli (e.g., trivia questions) about which they report being curious (Kang et al., 2009; Marvin & Shohamy, 2016). A recent study even found that participants were willing to undergo electric shocks to learn information that induced self-reported curiosity (Lau et al., 2020).

How can these two explanations for information seeking—uncertainty reduction and curiosity—be reconciled? ² One clue may be gleaned from the experimental paradigms that tend to accompany them. Studies advocating an uncertainty-reduction explanation for information seeking often employ a class of experiments in which participants can seek advance knowledge of an upcoming outcome, almost always a reward (e.g., Bennett et al., 2020; Bromberg-Martin & Hikosaka, 2009; Eliaz & Schotter, 2007). These are often called temporal reduction of uncertainty paradigms (e.g., Kidd & Hayden, 2015), but to distinguish them from other information-seeking paradigms which also resolve uncertainty, we will call them reward-outcome paradigms. In reward-outcome paradigms, participants can choose between two options, one that delivers early knowledge about a small monetary or food reward, and another that delivers no knowledge of the reward. This information is non-instrumental as the participant's choice does not alter the total reward obtained at the end of the experiment. For example, in Bennett et al. (2020), participants can choose to pay a small sum of money to view a series of stimuli that reveal whether they will win or lose the trial, or else pay no money and view perceptually equivalent stimuli providing no information about the outcome. Whatever their choice, they will learn the outcome at the end of the trial.

Meanwhile, studies that assess how curiosity relates to information seeking often draw on very different experimental paradigms; most commonly trivia paradigms, where the information provided is the answer to general-knowledge questions (e.g., "Which bird is the international symbol of happiness?"; Kang et al., 2009;

¹ For example, new knowledge can cause people to update their prior beliefs to become less certain about their previous knowledge. However, in the context of current information-seeking experiments, the choice to seek information always entails a reduction of uncertainty.

² Because curiosity has a long history and many different definitions, it is important to acknowledge that curiosity has sometimes been defined as a desire to reduce aversive feelings of uncertainty (Berlyne, 1954; Golman & Loewenstein, 2018; Jepma et al., 2012; Kobayashi et al., 2019; Lau et al., 2020; Ligneul et al., 2018). This perspective features in the influential "information gap" model of curiosity, whereby curiosity is considered an aversive state produced by awareness of explicit gaps in one's knowledge, which can be eliminated by successfully seeking information (Loewenstein, 1994). This would suggest that one way to reconcile the curiosity and uncertainty-reduction explanation for

information seeking is to consider them the same construct. However, this explanation is arguably unsatisfying given the extensively documented neurobiological differences between states of exploration/curiosity versus anxiety/fear (Panksepp, 2004), the distinct personality traits related to tendencies to be curious and tendencies to be anxious about uncertainty (Jach & Smillie, 2019; Kashdan et al., 2018), and, indeed, the negative correlation observed between trait curiosity and uncertainty intolerance (Jach & Smillie, 2021). However, in the following sections we make some space for this interpretation by distinguishing between distinct *interest* versus *deprivation* facets of curiosity, and how they differentially relate to anticipation about outcomes and uncertainty intolerance.

Marvin & Shohamy, 2016). As in reward-outcome paradigms, the information within trivia paradigms is non-instrumental (i.e., trivia answers do not alter the likelihood of receiving a specific extrinsic reward).

An advantage of using similar experimental designs is that results can be built cumulatively from and compared closely to prior research. However, there are downsides to this consistency: no setting is truly neutral, and by aiming for uniform experimental environments and task structures, researchers may unknowingly constrain potential cognitive, emotional, or motivational affordances. For example, in reward-outcome paradigms, even though information doesn't alter the reward on each trial, it informs participants about whether or not they will soon gain a reward. This task structure may be particularly likely to provoke information seeking in order to reduce uncertainty, because participants' uncertainty about their future reward may elicit anxiety concerning their financial gains, which could lead to information seeking to reduce the aversion caused by this uncertainty. Further, it has been established that monetary rewards undermine intrinsic motivations (such as curiosity) to engage with a task (Deci et al., 1999; Murayama et al., 2010). Thus, this task structure could unknowingly have reduced possible curiosity-driven motivations by including reward-information as its only information stimuli. Moreover, as individuals differ in their tolerance of uncertainty (Carleton et al., 2012), this paradigm may evoke information-seeking only in people who are relatively high in uncertainty intolerance as a trait.

This can be contrasted with trivia paradigms. Trivia questions tend to include a variety of content and topics and consequently might be experienced as more intellectually stimulating and positive than reward-outcome paradigms. These elements may make trivia paradigms more likely to elicit curiosity-driven information seeking than other motivations, such as anxiety. Further, just as uncertainty intolerance is a trait-like individual difference, one's level of curiosity is also (Kashdan et al., 2018; Litman, 2008). Without measuring trait levels of curiosity, it's not possible to assess whether

the individuals choosing to seek information in trivia paradigms are only those who are more generally curious.

Taken together, these considerations suggest that no one task purporting to measure information seeking may be sufficient to measure all motivations in all people: choices observed in a given task cannot be taken to be representative of all situations, and, even in identical situations, there are individual differences both in how situations are perceived and in the degree to which the same situational affordances matter. Instead, it may be beneficial to compare information seeking across people and contexts. This is the aim of the current paper: we present a conceptual model that describes how different personality traits and contextual factors may drive different instances of information seeking, and test model predictions across multiple information-seeking paradigms.

A Conceptual Model of Information Seeking

Our model (Figure 1) specifies two pathways to information seeking: one characterized by the motivation to explore the unknown, and one characterized by the motivation to seek safety.

The motivations to explore or seek safety represent two fundamentally different action tendencies, one approach-oriented and one mostly avoidance-oriented³ (Carver & Scheier, 1998). The contrast between exploration and safety, or approach and avoidance, has many similar comparisons across various literatures, including the behavioral activation and behavioral inhibition systems from personality neuroscience (Smillie, 2008), the SEEKING and FEAR systems from affective neuroscience (Panksepp, 2004), promotion and prevention focus from theories of self-regulation (Higgins, 1998), and self-direction versus security values from social psychology (Schwartz, 1992). The prevalence of these two motivational directions across such a wide gamut suggests an appropriate starting point from which to consider different motivations to seek information.

Figure 1. Conceptual model of how personality and situation perceptions relate to information-seeking motivations. The blue text describes how we are operationalizing the constructs in the current research.

³ We write “mostly” avoidance-oriented because a drive to seek safety is grounded in an avoidance of the unknown, but also involves an approach of information to facilitate this

avoidance of uncertainty. This is consistent with action tendencies being dynamic processes that involve cycles between approach and avoidance (Carver, 2006)

The degree to which a person seeks information via an exploration or safety motive is proposed to be a function of both situational factors (i.e., situation perception and momentary emotions) and personal factors (i.e., stable individual differences in personality). This aligns with foundational psychological theory that behavior is a function of both the person and the situation (Lewin, 1936). As we describe, state and trait curiosity are major drivers of the exploration pathway, and state and trait uncertainty intolerance are major drivers of the safety pathway. This suggests that both explanations for non-instrumental information-seeking that have emerged in the literature—uncertainty reduction and curiosity—may be correct, depending on the situation and the person. The remainder of this section outlines our logic.

The Person

Personality traits describe typical patterns of emotion, behavior, thought, and desire (John & Srivastava, 1999). The most relevant personality traits for current purposes are curiosity and uncertainty intolerance. Curiosity describes the desire and interest to explore new, uncertain, and/or complex events (Kashdan et al., 2018; Spielberger & Starr, 1994). Trait curiosity comprises multiple dimensions, the two most relevant being deprivation sensitivity (representing *desire* to explore, involving feelings of deprivation and a pressing need to know) and joyous exploration (representing *interest* to explore, where you do not feel deficient of information but would nonetheless enjoy exploring something new; Kashdan et al., 2018; Litman, 2008). Conversely, uncertainty intolerance describes the tendency to find the negative possibilities in the unknown threatening and unacceptable (Carleton et al., 2007).

Personality traits are also hierarchically-organized, with higher-level traits formed from the shared variance of lower-level traits (often called *facets*). Curiosity, particularly joyous exploration, is often considered a facet of the broader personality dimension *openness/intellect*, describing variance in imagination, creativity, and intellectual engagement (Kashdan et al., 2018; Silvia & Christensen, 2020; Woo et al., 2014). Further, trait uncertainty intolerance can be considered a facet of neuroticism, a broad personality dimension describing variance in negative emotionality and anxious/depressive tendencies (Berenbaum et al., 2008; de Bruin et al., 2007; Jach & Smillie, 2019; McEvoy & Mahoney, 2012; see Markon, 2009, for a discussion of how lower-order traits can be located within personality dimensions).

For any personality trait, each person's score can be thought of as approximating the mean in a density distribution of psychological states (Fleeson, 2001; Fleeson & Gallagher, 2009). For example, a person scoring relatively high on trait uncertainty intolerance is unlikely to feel an aversion to uncertainty in all situations in all times. However, they will tend to feel negative emotions toward uncertainty more frequently and more intensely than a person scoring lower on the trait. Likewise for curiosity, people who score higher in trait joyous exploration or deprivation sensitivity are more likely to experience more intense feelings of interest or

deprivation, respectively, than a person scoring low on that trait. Thus, because personality traits summarize tendencies of psychological states, assessing trait scores should provide an indication of how likely a person is to experience emotions beyond that indicated by that particular situation.

The Situation

Different situations may *afford* (i.e., make possible or provide a context for) different thoughts, behaviors, and emotions (Stoffregen, 2004; Thielmann et al., 2020). A key development in the empirical study of situation effects has been to assess individuals' perceptions of situations (Horstmann et al., 2018), and researchers of individual differences have proposed several taxonomies of the main dimensions of situation perceptions that converge on the existence of five or six robust dimensions (Asendorpf & Rauthmann, 2020). From this literature we identify three key situation dimensions that may be relevant to information-seeking. First is the degree to which the situation affords *positivity*, describing situations that are perceived to be enjoyable, playful, humorous, simple, and easy. Second is the degree that the situation affords *negativity*, describing how stressful, anxiety-provoking, or frustrating the situation is thought to be. Third is to what degree the situation is perceived to afford *intellect*, describing whether the situation offers opportunities for intellectual engagement and cognitive processing.

We propose that in situations where an opportunity to gain information exists, perceptions of these situations play an important role in influencing emotions and attitudes toward potential information gain, which has flow-on effects to motivations to seek information. Specifically, when the situation is perceived to be positive, they are more likely to experience positive emotions (e.g., eagerness, happiness). When the situation is both positive and intellectually engaging, they will be likely to experience feelings of interest-oriented curiosity. These positive emotions spur exploration-oriented information seeking as the person is optimistic about the possibilities for growth and understanding that may be afforded by transforming the unknown into the known (DeYoung, 2013).

Conversely, when people are in situations that they perceive to be negative, they are more likely to feel negative emotions (e.g., stress, anxiety, fear) in that situation. When these negative emotions are related to the lack of information itself, then this will be experienced as anxiety related to uncertainty, and will spur safety-oriented information seeking to reduce the negative emotions evoked by the unknown (Hirsh et al., 2012). Finally, when momentary anxiety toward uncertainty is felt in situations that people *also* rate as intellectually engaging, then this is likely to spur dual information-seeking motivations both to reduce negative emotions induced by uncertainty *and* to approach the new knowledge available from the unknown. This reflects a combination of both approach and avoidance tendencies and will be experienced as a feeling of deprivation-oriented curiosity.

Which elements of the situations (i.e., situational *cues*; Rauthmann et al., 2014) might create a context where

information gain is perceived as more intellectually engaging, positive, or negative? If the information provides an opportunity to learn more about the world, consider complex topics, or question one's existing assumptions, then we predict this will influence the situation to be perceived as higher in intellect. Further, if the information is novel, easy to understand, and contains high variety and surprise, it may be perceived more positively. Similar to appraisal theories of interest (Silvia, 2005, 2008), we predict these elements may lead the situation to be rated as higher in positivity and intellectual engagement, spurring interest-oriented curiosity. This collection of cues is likely to describe trivia paradigms, which sample from a variety of content and topics and allow participants to learn new things (and thus expand their internal model of the world). Thus, trivia paradigms would be expected to elicit interest-oriented curiosity and to be rated as higher in positivity and intellect.

Second, we propose that contexts that signify possible threats to one's safety are likely to lead the situation of uncertainty to be perceived as more negative and less positive. "Safety" here is relative and does not mean to imply that only life-threatening outcomes are relevant. Instead, any chance of losing or failing to gain something can impact one's perceived safety. This means that monetary and social threats are relevant in addition to physical threats.

When information informs the person about their safety, this provides psychological utility even when the information will not change the eventual outcome, because knowing the outcome a little in advance allows the person to either become less anxious (as they know they will be safe) or allows them to mentally prepare for a negative outcome (Wu, 1999). Thus, the information facilitates self-regulatory processes rather than being intrinsically valuable. An example of where information may serve this purpose may be compulsively checking the news to gain more information about world disasters, such as wars or pandemics. This context signifies a potential threat to oneself and loved ones, and although news-checking does not change the current state of the world, information may allow one to temporarily alleviate the anxiety elicited by uncertainty about one's safety. In experimental paradigms, the stakes are clearly far lower than for real-world scenarios. Nevertheless, when the paradigm provides information about one's safety or lack thereof, we posit that this cues attention to these factors and may cause the situation to be perceived as somewhat stressful and anxiety-provoking; emotions that can be eliminated by early information gain. As information in reward-outcome paradigms informs participants about their upcoming monetary status, participants may be anxious about the upcoming reward and thus more likely to seek information to reduce the anxiety induced by uncertainty.

Finally, what cues would we expect to elicit deprivation-oriented curiosity? The drive to know the answer is conceived of as an intellectual and approach-oriented (to approach information for its own sake) but also as a way of escaping the aversive properties of uncertainty. Hence, we might expect that in all situations where information reduces uncertainty, deprivation-oriented curiosity would be relevant. This encompasses both the reward-outcome and trivia paradigms.

Connecting the Person and the Situation

Personality traits influence how a situation is perceived: openness/intellect predicts perceiving a situation as higher in intellect, whereas neuroticism predicts perceiving a situation as higher in negativity and lower in positivity (Rauthmann et al., 2014, 2015). As previously outlined, the way a situation is perceived will influence state emotions and the likelihood of seeking information via an exploration or safety pathway. Thus, personality traits are crucial variables to consider in relation to information seeking both because they describe tendencies toward psychological states (including emotional states) and because they change the way a situation is construed, which in turn influences state emotions. This makes it important to measure personality traits and to obtain a sample of sufficient size to obtain reliable estimates of the trait's correlates (Schönbrodt & Perugini, 2013).

Information Receipt and Reward

Finally, we expect that the receipt of information will elicit different emotional responses depending on the motivation to seek information. For those who sought information to explore, receipt of information might be more likely to activate positive emotions such as pleasure, interest, and surprise. In line with existing reinforcement learning models of curiosity (Murayama et al., 2019), these emotions act as reward signals, increasing the likelihood that information will be sought on the following trials. Conversely, for those who sought information to reduce the aversive feelings of uncertainty, a sense of relief from the elimination of anxiety may be felt. This reinforces behavior as people learn that they can reduce their anxiety by continuing to seek information.

Relations to Existing Research

As the majority of information-seeking studies have not explicitly considered situational or person-specific factors for choice motivation, there is minimal direct existing evidence for our full conceptual model. However, several studies support elements of the theory. One study assessed individual differences related to information seeking in a reward-outcome paradigm (Bennett et al., 2020). They found that neuroticism and obsessive-compulsive tendencies correlated with seeking information. A second paper using the same paradigm across two studies found that openness/intellect did *not* predict seeking information (Smillie et al., 2021). The results of these studies are in line with our assertion that reward-outcome tasks will typically elicit safety motivations but not exploration motivations. Further, Jach and Smillie (2021) assessed information seeking with a paradigm that amalgamated reward-outcome and trivia paradigms. Here, participants were immediately informed that they had won or lost a trial, and then were allowed to pay (in units of time) to learn more information about that trial. Thus, uncertainty related to participants' monetary status was removed, but the information that they gained provided a greater context to their reward-related outcome. In this paradigm, the authors observed that both joyous exploration and uncertainty intolerance independently predicted seeking information. Taken

together, these studies provide initial evidence for the impact of personality traits on information seeking preference. However, none of these studies assessed state emotions or situation perceptions in their results, and so cannot speak to this component of our model. On the other hand, studies using trivia paradigms have nearly always included measures of state curiosity and observed that momentary curiosity strongly predicted information seeking (Kang et al., 2009; Lau et al., 2020; Marvin & Shohamy, 2016). But as these studies did not include measures of trait curiosity, it remains unknown to what degree state and trait curiosity correlate in these tasks. Finally, substantial prior research has focussed on the structure of curiosity and possible emotional or situational processes spurring curious exploration (e.g., Ainley, 1987; Berlyne, 1954; Lau et al., 2020; Litman, 2005; Loewenstein, 1994; Marvin & Shohamy, 2016). But this research has rarely considered person, emotion, and situation factors together, or conducted experiments where these elements can be jointly measured and manipulated.

Testing This Theory Across Situations

No prior study has included both a reward-outcome paradigm and a trivia paradigm within the same study, nor measured the divergent validity of trait curiosity and uncertainty intolerance across paradigms. We therefore present the first studies of choice preferences across two paradigms that each purport to measure non-instrumental information seeking.

Trivia paradigms are not as tightly controlled as reward-outcome paradigms because the amount of expected information can neither be held constant across trials (i.e., some questions will be more or less difficult than other questions) nor across participants (i.e., some participants will know more about certain content or topics than other participants). Further, due to their popularity in everyday life (e.g., pub quizzes) trivia questions may have established scripts and associations to games and social rewards for correct answers, and hence provide an alternative motive for the answer. To improve on these limitations, we generated two novel stimulus sets.

First, midway through each trial of the Trivia paradigm we asked participants if they would like to know some “bonus” information. This information provides more context to the trivia question but, crucially, does not help to answer the trivia question. As the bonus information is a complete unknown on each trial, the amount of expected information is constant across trials and participants. Moreover, as the bonus information does not help to answer the trivia question, it is entirely non-instrumental in the context of the task.

Despite these advantages, a possible confound remains: individual differences in general knowledge mean that the information gained from bonus information will not be equal between people, even if expected information is held constant. Although this cannot affect choice preferences for the first trial, it might affect choices on later trials (e.g., a participant might be less willing to pay for bonus information if they didn’t gain much new knowledge initially). Thus, we included a final stimulus set that accounts for this confound. Midway through each trial of the reward-outcome paradigm, we presented a coin

featuring a word written in Chinese characters, and asked participants if they would like to know the translation of this character. Within a participant sample who cannot read Chinese, both the predicted and received information is equivalent across participants and trials. Moreover, by using simple words as stimuli, choices will not relate to existing interest niches as they could for trivia and bonus information. Finally, by embedding this task within the reward-outcome paradigm, all peripheral situational elements of the two measures are identical.

Aims and Hypotheses

Our aims for this research are twofold. First, we will explore how non-instrumental information-seeking preferences differ across four stimulus sets (hereafter termed the Trivia stimuli, Bonus stimuli, Reward-Outcome stimuli, and Character stimuli). Second, we will evaluate evidence for our working model via model-derived predictions regarding how information-seeking preferences relate to personality traits, situation ratings, and state emotions.

For our first aim, we expect that there will be a difference in choice distributions between the Reward-Outcome stimuli and other stimulus sets due to differences in how this situation is perceived, as previously described. As no prior study has compared information preferences simultaneously across reward-outcome paradigms and other paradigms that do not involve rewards, we have no specific predictions for the distribution of information-seeking responses.

For our second aim, our model yields clear predictions regarding how information seeking should map to situation ratings, state responses, and personality traits. Specifically, information from the Trivia, Bonus, and Character stimulus sets will be chosen more often by individuals higher in trait curiosity (joyous exploration and deprivation sensitivity) and openness/intellect, and these stimuli will be accompanied by states reflecting interest-oriented curiosity and be perceived as comparatively positive, intellectually engaging, and not negative. This represents a general exploratory motivation for obtaining information. In contrast, information from the Reward-Outcome stimuli will be chosen more often by individuals higher in uncertainty intolerance, deprivation sensitivity, and neuroticism, and these stimuli will be accompanied by negative emotions and be perceived as comparatively negative, not positive, and not intellectually engaging. This represents a general safety motivation for obtaining information.

These predictions can be operationalized with two broad hypotheses, each of which houses several specific predictions (see Table 1). Our hypotheses, method, analysis plan, and conceptual model were pre-registered on the Open Science Framework (OSF; <https://osf.io/7k83t>).

Note that we specified a third broad hypothesis concerning how pre- and post-information state ratings would correlate with epistemic emotions, situation ratings, and Big 5 personality traits. Results for this hypothesis are included in the supplementary materials rather than the main text because high intercorrelations between state ratings made them relatively uninformative.

Table 1
Study 1 Hypotheses

Broad Hypothesis	Precise Hypothesis
1. Trait emotions and Big Five traits will predict information-seeking preferences depending on the particular context.	Openness/intellect and joyous exploration will positively predict information seeking for Trivia, Bonus, and Character stimuli, and will continue to do so when controlling for intelligence. The relation between openness/intellect and information seeking will be mediated by state curiosity.
	Deprivation sensitivity will positively predict seeking information for the Reward-Outcome, Trivia, and Character stimuli.
	Openness/intellect, joyous exploration, and intelligence will not positively predict seeking information for the Reward-Outcome stimuli: the relation may be non-significant or negative.
	Neuroticism and uncertainty intolerance will positively predict seeking information for the Reward-Outcome stimuli, but not the Character, Trivia, or Bonus stimuli.
2. The different information-seeking paradigms will be rated differently by participants on average.	For situation ratings, on average, participants will rate Trivia and Character stimuli as higher on intellect and positivity and lower on negativity than the Reward-Outcome stimuli.
	The adapted item from the intellect sub-scale “the [task] provided an opportunity to learn about unusual ideas or points of view” will be endorsed more for the Trivia and Character than for Reward-Outcome stimuli.
	Prior to receiving information, people will report on average being less bothered, uncertain, and needing to know the answer for Trivia and Character compared to Reward-Outcome stimuli. Conversely, they will report higher average curiosity for Trivia and Character than for Reward-Outcome stimuli.
	For post-information responses, people will report higher average pleasure, interest, and surprise for Trivia, Character, and Bonus stimuli than for Reward-Outcome stimuli. Conversely, when participants make the correct answer, there will be higher average reported relief for the Reward-Outcome stimuli compared to Trivia and Character.

Study 1

Method

Participants

Ethical approval was provided by the University of Melbourne Human Ethics Advisory Group (ID 2056233.2). In total, 449 participants from the online platform *Prolific Academic* completed the study or required compensation despite non-completion (e.g., technical difficulties). Participants were required to be English-speaking monolinguals to ensure that they could not read Chinese characters used in one part of the study. Participants were paid £6.70 plus a £0.50 bonus, which equated to an average payment of £5.45 per hour.

As preregistered, participants were excluded from analyses if they (1) provided an average response time faster than 1 second per questionnaire item from the BFAS questionnaire ($n = 6$); (2) provided non-sensical text, an irrelevant response, or no response to an open-ended question asking them to list some current hobbies or interests, ($n = 0$); (3) provided a mean of less than 4 out of 7 to a 6-item self-report survey of data quality (Wood et al., 2017; e.g., *I exerted sufficient effort on this survey*; $n = 0$); (4) provided a

response of more than 2 years’ discrepancy to two separate questions about participant age ($n = 1$) or (5) completed less than 90% of the study or did not reach the end of the study ($n = 2$)⁴. Additionally, we detected two participants who had attempted to complete the survey twice, entering a different Prolific ID than their automatically-provided ID for their second attempt. These four entries were removed as they indicated dishonest responding.

Following participant exclusion, our final sample comprised 436 participants (49% female, 49% male, and 1.8% non-cisgender), which exceeded our prespecified minimum sample of 350. Age ranged from 18 to 78 (mean = 34.22, SD = 11.92). Participants were currently living in the United Kingdom ($n = 222$), the United States ($n = 173$), Canada ($n = 29$), Australia ($n = 5$), Ireland ($n = 3$), or New Zealand ($n = 3$).

Procedure

Participants were asked to complete an online survey that included three “games” (one of which was a cognitive ability test), ratings of their personality, and demographic information. Following each game, participants also rated their perception of that situation and provided an optional open-ended comment on the

⁴ Note that Criterion 5 slightly deviates from our pre-registration, where we only wrote that we would remove participants who completed less than 90% of the study. Two excluded participants completed more than 90%, but due to technical difficulties, we could not recover their survey

responses in the correct format. Consequently, these participants were excluded prior to analyses.

game. The survey was created with Qualtrics software and can be viewed in our OSF documentation.

The two games from which we collected state ratings and information-seeking decisions were a Trivia paradigm (including the Trivia and Bonus information-seeking stimulus sets) and a Coin Flip paradigm (including the Reward-Outcome and Chinese Character stimulus sets; Figure 2). Each game comprised 20 trials, the first 10 of which were “no-choice” trials that automatically revealed information following a 2-second delay. This design was chosen to permit full-sample analysis of post-information ratings, as only those who see information can rate emotions evoked by that information. On the remaining 10 trials, participants could choose to pay time (5 seconds) to seek information, else proceed immediately to the next part of the game. No-choice trials were presented in a block before choice trials, and trials were randomized within each block. Participants first completed the Trivia paradigm, followed by personality surveys, the cognitive ability test, and finally the Coin Flip paradigm, after which they were fully debriefed and reimbursed for their time.

Trivia Game (Trivia and Bonus Stimulus Sets).

On each trial, participants were shown a trivia question (e.g., *What disability did Thomas Edison suffer from?*) drawn from an existing database of trivia questions (Fastrich et al., 2018). They entered a free-text answer, and then provided *pre-information* emotion and cognition ratings (described in the *Materials* section below). The trivia game included two stimulus sets in which information could be provided to participants: the *answer* to the trivia question (Trivia stimuli), and *bonus* information (Bonus stimuli). The Trivia stimulus set allows participants to learn the answer to the trivia question (e.g., in the case of Thomas Edison’s disability, *deafness*), whereas the Bonus stimulus set provides some additional context to the question (e.g., *Edison set up his first lab in his parent’s basement at the age of 10*). Participants were explicitly told that bonus information would not provide any clues to the answer. The order of trivia answer information and bonus information within each trial was counterbalanced across trials. Finally, following information, participants provided *post-information* ratings of their emotions.

Figure 2. Example trial. (A) The trivia questions paradigm (including both Trivia and Bonus stimulus sets). (B) The Coin Flip paradigm (including Reward-Outcome and Character stimulus sets).

Coin Flip Game (Reward-Outcome and Character Stimulus Sets).

Participants were informed that on each trial, the computer would flip a virtual coin that had 50% chance of falling on heads and 50% chance of falling on tails, and their task was to guess which side the coin would land on. For each trial where they guessed correctly, they would win 5p that would be added to their total at the end of the study (to ensure equal success and failure, we set each participant to win 50% of their trials but randomized the occurrence of this outcome across trials).

As in the Trivia game, the Coin Flip included two distinct information stimulus sets. First, participants had the option to learn the outcome of the coin flip (Reward-Outcome stimulus set), thereby learning whether they had guessed correctly for that trial. Importantly, participants were explicitly informed that their final winnings would be revealed at the end of the game, making this information economically non-instrumental.

Second, a word written on the coin was revealed to participants. This word was written in Chinese characters and could thus not be understood by our English-speaking monolingual participants. Participants were given the option to see the English translation of this word (Character stimulus set) or continue immediately to the next trial. Thus, the Character stimuli provided some additional contextual information but did not provide any clues to the outcome of the trial.

Materials

Information Seeking. Information-seeking choices were assessed using four different stimulus sets, as described above: (1) the answer to trivia questions (Trivia stimuli), (2) bonus trivia information (Bonus stimuli), (3) the reward-outcome of a heads/tails coin flip guess (Reward-Outcome stimuli), and (4) the translation of the Chinese characters written on the coin (Character stimuli). Each stimulus set included 10 trials, producing 40 information-seeking choices per participant. The cost to seek information was always a 5-second time delay.

State Emotion and Cognition Ratings. For the Trivia, Reward-Outcome, and Character stimulus sets, prior to the choice to seek information, participants responded to the following items on a 5-point Likert scale from 1 (*not at all*) to 5 (*extremely*): *I am confident I know the answer*; *I am curious about the answer*; *I am bothered by not knowing the answer*; *I feel uncertain about the answer*; and *I need to know the answer*. For the Character stimuli, “*about the answer*” was modified to “*what the word means*” (e.g., *I am confident I know what the word means*). We did not collect pre-information ratings for the Bonus stimuli as we thought this would be confusing for participants, given there was no question posed or context for them to consider prior to the choice to seek information.

After receiving information, participants were asked *How well does each word describe how you feel?* and rated how *surprised*, *relieved*, *interested*, *amazed*, and *pleased* they were on a scale from 1 (*not at all*) to 5 (*extremely*). Post-information ratings were collected for all four stimulus sets. Because participants cannot provide post-information ratings on trials for which they chose not

to seek information (i.e., post-information rating data from trials 11-20 were incomplete), all assessments of state ratings were performed on trials 1-10.

Situation Perception Ratings. Participants rated their perceptions of the information-seeking situations for the Trivia, Reward-Outcome, and Character stimulus sets using the DIAMONDS (Rauthmann et al., 2014), a taxonomy of perceived psychological characteristics of situations. The 32 items are divided into eight four-item dimensions that form the DIAMONDS acronym (Duty, Intellect, Adversity, Mating, pOsitivity, Negativity, Deception, and Sociality). Responses were collected on a 5-point Likert scale from 1 (*Not at all*) to 5 (*Extremely*). To reduce the total survey length, we chose to only measure the dimensions that we judged could be relevant: Intellect (e.g., *affords an opportunity to demonstrate intellectual capacity*), pOsitivity (e.g., *situation is playful*), Negativity (e.g., *situation entails frustration*), and Duty (e.g., *a job needs to be done*). As *Duty* is not an element of our conceptual model, we do not include results for this dimension within the manuscript, but it can be accessed via our open data.

We altered DIAMONDS items in the following ways: (1) We changed the scale from the present to the past tense and related it to the task that had just been completed (e.g., “*Situation is enjoyable*” became, “*The [task] was enjoyable*”); (2) For the Intellect sub-scale, we did not include the item *Situation evokes values concerning lifestyles or politics* because it was not relevant, and we altered the item *Situation affords an opportunity to express unusual ideas or points of view to the [task] provided an opportunity to learn about unusual ideas or points of view*. Finally, we changed the Negativity item from *Situation could entail stress or trauma to the [task] was stressful*. The Trivia and Bonus stimuli included a combined situation perception option (as we assumed participants would not accurately distinguish between the two parts of the paradigm) whereas the Reward-Outcome and Character stimuli included separate situation perception surveys.

Personality Traits. All trait responses were collected on a 5-point scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*).

Big 5. We measured broad personality dimensions with the Big Five Aspect Scales (DeYoung et al., 2007), a 100-item measure that assesses both broad traits (openness/intellect, neuroticism, extraversion, agreeableness, and conscientiousness), as well as each trait’s two lower-level *aspects*. The traits included in our hypotheses included openness/intellect, composed of the *intellect* (e.g., *Like to solve complex problems*) and *openness* aspect (e.g., *Enjoy the beauty of nature*); and neuroticism, composed of the *withdrawal* (e.g., *Worry about things*) and *volatility* (e.g., *Get easily agitated*) aspect. For present research questions, we focused on the trait- and facet-level rather than aspects.

Curiosity. Participants completed the Five Dimensional Curiosity Inventory (5DCI; Kashdan et al., 2018) and the Epistemic Curiosity Questionnaire (Litman, 2008). The 5DCI is a broad scale including five distinct factors, each composed of five items. For current purposes, our research questions concern joyous exploration, describing an interest in exploring things that are novel or

unknown (e.g., *I find it fascinating to learn new information*), and deprivation sensitivity, describing an intense need to know (e.g., *I work relentlessly at problems that I feel must be solved*). These are also the two subscales that feature in Litman (2008; called *Interest-type* and *Deprivation-type*). As many of the items from Litman (2008) overlap closely or exactly with the joyous exploration and deprivation sensitivity subscales of Kashdan et al. (2018) we added the non-overlapping items from Litman (2008) into an overall 8-item measure of joyous exploration and a 6-item measure of deprivation sensitivity, as preregistered.

Uncertainty intolerance. Uncertainty intolerance was measured with the 12-item Intolerance of Uncertainty scale (Carleton et al., 2007). Additionally, we included a 13-item measure of ambiguity tolerance (McLain, 2009), which can be considered an alternate measure of uncertainty intolerance. However, predictions made were specific to the Intolerance of Uncertainty scale, and ambiguity tolerance was included only for exploratory future research with our open data, given that it has been previously assessed in studies of information seeking (Jach & Smillie, 2021).

Cognitive Ability. Individuals who are more intelligent tend to have superior general knowledge and reasoning abilities, which could influence choices in unforeseen ways (e.g., they could have a higher baseline likelihood of knowing the trivia answers or the bonus information; they might try to recognize symbols from the Chinese characters to remember for later trials). As intelligence tends to be correlated with openness/intellect (DeYoung, 2020), of which curiosity can be considered a facet, this relation to intelligence might provide an alternative explanation for why the desire to know information may be linked to curiosity. Thus, it is important to measure and control for intelligence when predicting information-seeking choice across these stimuli. The international cognitive ability resource (ICAR) sample test (Condon & Revelle, 2014) is a 16-item open-source intelligence test measuring letter and number reasoning, matrix reasoning, three-dimensional rotation, and verbal reasoning. Due to time constraints, we did not include the four 3-dimensional rotation questions, leading to a 12-item test. This is consistent with reduced versions of the scale used in several prior studies (Dworak et al., 2020). During the experiment, participants were told that the task was a decision-making game with correct answers; the debrief statement later revealed they had completed an intelligence test.

Data Analysis

All analyses were conducted in R Version 4.0.1 (R Core Team, 2020). Within R, the following packages were used: tidyverse (Wickham et al., 2019), lavaan (Rosseel, 2012), psych (Revelle, 2019), BayesFactor (Morey & Rouder, 2018), bain (Gu et al., 2020), lme4 (Bates et al., 2015), lmerTest (Kuznetsova et al., 2017), reshape2 (Wickham, 2007), cowplot (Wilke, 2019), semTools (Jorgensen et al., 2020), RColorBrewer (Neuwirth, 2014), and corrplot (Wei & Simko, 2017).

Except where noted, confirmatory analyses followed our pre-registered plan. For Hypothesis 1, we employed structural equation models predicting information seeking across the four stimulus sets from our variables of interest⁵. Both personality traits (predictors) and information seeking (outcomes) were represented as latent variables, thereby explicitly accounting for measurement error and providing a more accurate estimate of mean values and resultant effects (Westfall & Yarkoni, 2016). As information seeking was non-normally distributed (Table 2), a robust maximum likelihood estimator with a Sartorra-Bentler scaled test statistic and robust standard errors was used. Further, for predictions of null effects in Hypothesis 1, the R package *bain* (Gu et al., 2020) was used to compute Bayes Factors from the regression coefficients derived from the aforementioned structural equation models⁶. These analyses compare a hypothesis in which the regression coefficient is zero to an unconstrained hypothesis where the regression coefficient is nonzero. The Bayes Factor (BF_{01}) quantifies the support for the first (null) hypothesis relative to the second (alternative), using default uninformative priors (described further in Hoijtink et al., 2019; Van Lissa et al., 2020). Bayes Factors of 1 indicate no preference for either hypothesis, whereas Bayes Factors greater than 1 provide evidence for the null hypothesis and Bayes Factors less than 1 provide evidence for the alternative hypothesis. Bayes Factors greater than 3 or less than 1/3 have been proposed to provide substantial evidence for the null and alternative hypotheses, respectively (Jeffreys, 1961), and we preregistered these thresholds for the current study.

For Hypothesis 2, we used repeated-measures ANOVAs on mean-scored variables. For these analyses, the categorical independent value is the particular information-seeking stimulus set, and the dependent variable is the relevant rating (pre- and post-information state ratings and situation ratings). We used post-hoc Wilcoxon signed-rank-tests to test our directional predictions, which were Bonferroni-corrected for multiple comparisons.

⁵ In our pre-registration, we stated that we would use latent multilevel models for Hypotheses 1 and 3 contingent on model convergence. However, it became apparent that a multilevel approach would not be necessary for our research questions. This is because, although our outcome variables (information seeking/state emotion and cognition ratings) include multiple trials and can hence be represented at Level 1 (within-person) or 2 (between-persons), our predictor variables (i.e., traits/situation ratings) were measured only at Level 2. When a predictor is only measured at Level 2, the Level 1 outcome is aggregated to Level 2 for analyses. Thus, all that differs from a single-level model is that a multilevel approach explicitly models each individual's mean outcome, rather than solely the group's mean. This could affect the overall model fit, but for data where trials are nested within persons—and thus are automatically already clustered—it will not impact predictor parameter estimates, even when using a latent approach that accounts for sampling error (this is because the outcome is modeled a function of

the predictor's sampling error, which is nil if it is only measured at Level 2; see equations in Lüdtke et al., 2008). Indeed, for Hypothesis 1, a single-level fully latent approach is arguably a better choice than a latent multilevel approach because it models information seeking as a latent variable (not an aggregated mean), thereby accounting for measurement error.

⁶ This also diverges from our preregistration, where we wrote that we would compute separate Bayesian regressions on observed variables (Rouder & Morey, 2012). The current method is better as the Bayes factors are computed directly from parameter estimates that account for measurement error, thus providing more accurate estimates of relative evidence for the null or alternative hypotheses. However, to be consistent with our preregistration, the supplementary information contains all analyses under the method originally planned.

Results

Descriptive Statistics

Trait Scores, State Scores, and Situation Ratings. Table 2 shows descriptive statistics for information-seeking within each stimulus set, mean personality traits, and mean situation ratings. All variables demonstrated high internal consistency (ω and α). Skew and kurtosis values indicated that trait scores were approximately normally distributed, but information-seeking choices were often not normally distributed. On average, participants correctly guessed 30% of trivia questions.

Information-Seeking Choices. Figure 3, Panel A shows choice preference across stimulus sets. Choices for the Trivia stimuli were uniformly distributed, indicating substantial variability in how often people paid a time-cost for the answer. Meanwhile, responses were positively skewed for the Bonus stimuli, with most people choosing not to seek information. The positive skew was even stronger for the Character stimuli, with the vast majority never seeking to know the translation of the Chinese character, and a tiny minority seeking information some or all of the time. Finally, responses for the Reward-Outcome stimuli were bimodal, with most people either never choosing to know if they had won the trial or always choosing to know if they had won the trial.

For each stimulus set, choices to seek information demonstrated high reliability (Table 1, Lines 1-4, ω and α), indicating that within a stimulus set choices to seek information were generally consistent across trials

relative to other participants. However, despite this consistency, there were general differences in choice behavior across time. Figure 3, Panel B shows the average choice to seek information over time, from the first trial in which participants could choose (Trial 11) to the last (Trial 20). As seen visually and as estimated by multilevel models predicting information seeking by trial, the proportion of participants choosing to seek Bonus and Reward-Outcome information declined over time (Bonus $t(3923) = -5.29, p < .001$; Reward-Outcome $t(3923) = -10.31, p < .001$) whereas the choice to seek the answer to trivia questions or translated characters remained relatively stable (Trivia $t(3923) = -1.41, p = .157$; Character $t(3923) = -0.98, p = .330$). Further, Figure 4 displays statistically significant zero-order correlations for most variables of interest. All four information-seeking choices were positively intercorrelated, but not so strongly as to suggest a single information-seeking construct: associations ranged from $r = .30$ (Reward-Outcome and Character; Trivia and Character; Bonus and Reward-Outcome) to $r = .54$ (Bonus and Character). The strength of association between responses to the Bonus and Character stimuli is striking given that these choices occurred in different games on opposite ends of the study survey, and echoes their similar distributions displayed in Figure 3, Panel A. Taken together, these patterns of choice behavior suggest that not all forms of non-instrumental information seeking are interchangeable, but rather are preferred by different people to different degrees. The following sections assess which factors may play a role in these mean differences and individual differences.

Table 2

Reliability and Descriptive Statistics for Information Seeking, Intelligence, Trait Measures, and Combined Situation Ratings

Variable	ω	α	M	SD	Min	Max	Skew	Kurtosis
Info Seeking (Trivia)	.87	.87	0.54	0.33	0	1	-0.13	-1.27
Info Seeking (Bonus)	.90	.90	0.18	0.28	0	1	1.91	2.69
Info Seeking (RO)	.97	.97	0.41	0.43	0	1	0.43	-1.61
Info Seeking (Char)	.93	.93	0.10	0.24	0	1	2.68	6.49
Correct Trivia Guesses	NA	NA	5.95	4.21	0	18	0.68	-0.23
Intelligence	.77	.77	0.60	0.25	0	1	-0.20	-0.92
Openness/Intellect	.44	.80	3.71	0.54	2.20	4.90	-0.21	-0.33
Neuroticism	.82	.94	2.94	0.87	1	5	-0.05	-0.83
Extraversion	.74	.92	3.14	0.75	1.25	4.80	-0.16	-0.48
Conscientiousness	.63	.89	3.49	0.67	1.60	5	-0.17	-0.42
Agreeableness	.71	.87	3.90	0.55	1.40	4.90	-0.64	0.48
Uncertainty Intolerance	.86	.86	3.31	0.73	1.17	5	-0.22	-0.30
Joyous Exploration	.84	.85	3.86	0.66	1.88	5	-0.42	-0.11
Deprivation Sensitivity	.75	.83	3.57	0.74	1	5	-0.49	0.03
pOsitivity	.68	.83	2.68	0.69	1.42	4.92	0.93	0.80
Negativity	.71	.90	1.74	0.71	1	4.92	1.39	1.94
Intellect	.80	.88	2.35	0.87	1	5	0.95	0.50

Note. Info = Information, RO = Reward-Outcome, Char = Translated Character, ω = Omega, α = alpha, M = Mean, SD = Standard deviation. The way in which Omega is calculated in this column depends on the putative internal factor structure and data type. Omega categorical is used for information seeking and intelligence, Omega hierarchical is used for Big 5 personality traits and situation ratings, and unidimensional Omega is used for uncertainty intolerance and curiosity. This is consistent with recent recommendations (Flora, 2020).

Figure 3. Information-seeking responses. RO = Reward-Outcome, Char = Character. (A) Proportion of information seeking across the four stimulus sets. (B) Mean post-information state ratings for each trial. The ribbon surrounding each mean depicts the standard error of the mean.

Figure 4. Pearson zero-order correlations of information seeking, personality trait scores, state curiosity, and situation ratings. Unshaded correlations are statistically non-significant. State curiosity and situation ratings (pOstivity, Negativity, and Intellect) are averaged over three stimulus sets (Trivia, Reward-Outcome, and Character). RO = Reward-Outcome, Char = Character, OI = Openness/Intellect, C = Conscientiousness, E = Extraversion, A = Agreeableness, N = neuroticism, IoU = Uncertainty intolerance, Cur_JE = trait Curiosity—Joyous Exploration, Cur_DS = trait curiosity—Deprivation Sensitivity.

Inferential Analyses: Pre-registered Hypotheses

Hypothesis 1. We hypothesized that openness/intellect and the joyous exploration facet of trait curiosity would positively predict information seeking in response to the Trivia, Bonus, and Character stimuli, and would continue to do so when controlling for intelligence. Meanwhile, we hypothesized that openness/intellect, joyous exploration, and intelligence would *not* predict information seeking for the Reward-Outcome stimuli. Finally, we predicted that the deprivation sensitivity facet of curiosity would positively predict seeking information for the Reward-Outcome stimuli in addition to the Trivia and Character stimuli. These hypotheses were supported (Table 3): openness/intellect and joyous exploration significantly predicted seeking information for the Trivia stimuli, the Bonus stimuli, and the Character stimuli, but

relations were not significant for the Reward-Outcome stimuli. Further, all results held when controlling for intelligence (Models 2 and 8, Table 3). Bayes Factors indicated substantial evidence for the null for openness/intellect predicting Reward-Outcome information seeking, both as a sole predictor ($BF_{01} = 6.52$) and when intelligence was added to the model (openness/intellect $BF_{01} = 4.92$; intelligence $BF_{01} = 14.10$). Joyous exploration followed a similar pattern, finding substantial evidence for the null as a single predictor ($BF_{01} = 3.65$), and anecdotal evidence for the null as a multivariate predictor (joyous exploration $BF_{01} = 2.76$; intelligence $BF_{01} = 14.12$). Meanwhile, deprivation sensitivity significantly predicted information seeking for the Reward-Outcome stimuli as well as all other stimulus sets. These results converged with straightforward zero-order correlations (Figure 4).

Table 3

Parameter Estimates and Model Fit Statistics of Structural Equation Models Predicting Information Seeking from Personality Trait Measures.

Model	Stimuli	Predictor/s	Parameter Estimates						Fit Indices		
			β	95% CI		SE	Z	p	CFI	RMSEA [95% CI]	SRMR
1. Openness/ Intellect	Trivia	Openness/ Intellect	0.14	[0.03,	0.25]	0.05	2.50	.012	.90	.04 [.04, .04]	.06
	Bonus	Openness/ Intellect	0.15	[0.04,	0.26]	0.06	2.67	.008			
	RO	Openness/ Intellect	0.08	[-0.02,	0.18]	0.05	1.53	.127			
	Char	Openness/ Intellect	0.18	[0.08,	0.28]	0.05	3.57	< .001			
2. Openness/ Intellect and Intelligence	Trivia	Openness/ Intellect	0.13	[0.02,	0.24]	0.06	2.35	.019	.90	.04 [.03, .04]	.05
	Trivia	Intelligence	0.08	[-0.04,	0.19]	0.06	1.33	.182			
	Bonus	Openness/ Intellect	0.15	[0.04,	0.26]	0.06	2.64	.008			
	Bonus	Intelligence	-0.01	[-0.14,	0.11]	0.06	-0.21	.832			
	RO	Openness/ Intellect	0.08	[-0.02,	0.18]	0.05	1.48	.138			
	RO	Intelligence	0.02	[-0.09,	0.12]	0.05	0.30	.761			
	Char	Openness/ Intellect	0.18	[0.09,	0.28]	0.05	3.66	< .001			
	Char	Intelligence	-0.07	[-0.19,	0.05]	0.06	-1.20	.231			
3. Mediation model 1: Predicting Trivia via state curiosity	Trivia	Openness/ Intellect (c)	0.04	[-0.06,	0.14]	0.05	0.75	.454	.76	.06 [.06, .07]	.07
	Curiosity	Openness/ Intellect (a)	0.23	[0.13,	0.32]	0.05	4.48	< .001			
	Trivia	Curiosity (b)	0.44	[0.35,	0.53]	0.05	9.44	< .001			
		Indirect Effect A*B	0.10	[0.05,	0.15]	0.02	3.99	< .001			
		Total Effect C+(A*B)	0.14	[0.03,	0.24]	0.05	2.50	.013			
4. Mediation model 2: Predicting Bonus	Bonus	Openness/ Intellect (c)	0.08	[-0.03,	0.18]	0.05	1.43	.152	.82	.05 [.05, .06]	.07
	Curiosity	Openness/ Intellect (a)	0.23	[0.13,	0.32]	0.05	4.48	< .001			
	Bonus	Curiosity (b)	0.32	[0.22,	0.42]	0.05	6.55	< .001			

via state curiosity		Indirect Effect A*B	0.07	[0.03,	0.11]	0.02	3.62	< .001			
		Total Effect C+(A*B)	0.15	[0.04,	0.26]	0.06	2.68	.007			
5. Mediation model 3: Predicting Character via state curiosity	Char	Openness/Intellect (c)	0.05	[-0.04,	0.14]	0.05	1.11	.268	.83	.07 [.07, .07]	.08
	Curiosity	Openness/Intellect (a)	0.25	[0.16,	0.34]	0.05	5.36	< .001			
	Char	Curiosity (b)	0.52	[0.41,	0.62]	0.05	9.54	< .001			
		Indirect Effect A*B	0.13	[0.07,	0.19]	0.03	4.28	< .001			
		Total Effect C+(A*B)	0.18	[0.08,	0.28]	0.05	3.58	< .001			
6. Mediation model 4: Predicting Reward-Outcome via state curiosity	RO	Openness/Intellect (c)	0.03	[-0.06,	0.12]	0.05	0.71	.481	.87	.07 [.07, .07]	.07
	Curiosity	Openness/Intellect (a)	0.09	[-0.02,	0.19]	0.05	1.66	.096			
	RO	Curiosity (b)	0.52	[0.44,	0.59]	0.04	13.15	< .001			
		Indirect Effect A*B	0.05	[-0.01,	0.10]	0.03	1.64	.102			
		Total Effect C+(A*B)	0.08	[-0.02,	0.18]	0.05	1.53	.127			
7. Joyous Exploration	Trivia	Joyous Exploration	0.21	[0.11,	0.32]	0.05	3.90	< .001	.97	.03 [.02, .03]	.04
	Bonus	Joyous Exploration	0.21	[0.10,	0.32]	0.05	3.85	< .001			
	RO	Joyous Exploration	0.10	[-0.00,	0.20]	0.05	1.87	.062			
	Char	Joyous Exploration	0.25	[0.16,	0.34]	0.05	5.51	< .001			
		Joyous Exploration	0.21	[0.10,	0.32]	0.06	3.79	< .001	.96	.03 [.02, .03]	.04
8. Joyous Exploration and Intelligence	Trivia	Intelligence	0.07	[-0.04,	0.19]	0.06	1.28	.200			
	Bonus	Joyous Exploration	0.21	[0.10,	0.32]	0.06	3.81	< .001			
	Bonus	Intelligence	-0.02	[-0.14,	0.10]	0.06	-0.25	.800			
	RO	Joyous Exploration	0.10	[-0.01,	0.20]	0.05	1.83	.067			
	RO	Intelligence	0.02	[-0.09,	0.12]	0.05	0.30	.764			
	Char	Joyous Exploration	0.25	[0.17,	0.34]	0.05	5.62	< .001			
	Char	Intelligence	-0.07	[-0.19,	0.04]	0.06	-1.26	.207			
9. Deprivation Sensitivity	Trivia	Deprivation	0.24	[0.12,	0.35]	0.06	4.08	< .001	.98	.03 [.02, .03]	.04
	Bonus	Deprivation	0.24	[0.14,	0.34]	0.05	4.56	< .001			
	RO	Deprivation	0.18	[0.07,	0.28]	0.05	3.38	.001			
	Char	Deprivation	0.14	[0.04,	0.24]	0.05	2.82	.005			
10. Neuroticism	Trivia	Neuroticism	0.10	[-0.01,	0.20]	0.05	1.82	.068	.91	.04 [.04, .05]	.05
	Bonus	Neuroticism	-0.04	[-0.14,	0.07]	0.05	-0.71	.479			
	RO	Neuroticism	0.01	[-0.09,	0.11]	0.05	0.26	.796			

	Char	Neuroticism	-0.12	[-0.21,	-0.03]	0.05	-2.50	.013			
11. Uncertainty Intolerance	Trivia	Uncertainty									
		Intolerance	0.08	[-0.03,	0.19]	0.06	1.49	.136	.95	.03 [.03, .04]	.05
	Bonus	Uncertainty									
		Intolerance	0.09	[-0.02,	0.20]	0.06	1.56	.119			
	RO	Uncertainty									
		Intolerance	0.07	[-0.03,	0.18]	0.05	1.39	.164			
	Char	Uncertainty									
		Intolerance	-0.09	[-0.20,	0.02]	0.06	-1.58	.114			

Note. For mediation models, state curiosity was computed from trials in the relevant stimulus set (Bonus and Trivia = curiosity in the Trivia game; RO = curiosity for the Reward-Outcome stimuli; Char = curiosity for the Character stimuli)

As we proposed that openness/intellect predicts seeking information partially because these individuals tend to feel greater instances of state curiosity, we hypothesized that the relation between openness/intellect and information seeking would be statistically mediated by state curiosity for the Trivia, Bonus, and Character stimuli. Table 3, Models 3-6 present formal latent mediation models testing the indirect effect of openness/intellect on information within each stimulus set. For Trivia, Bonus, and Character stimuli, openness/intellect was no longer a direct predictor of information seeking when accounting for state curiosity. However, openness/intellect significantly predicted state curiosity, and state curiosity was a strong and significant predictor of information-seeking choices. Further, a significant indirect effect of openness/intellect on information seeking via state curiosity was observed, suggesting a full mediation, consistent with our theory. Conversely, for Reward-Outcome stimuli (Model 6), only reported curiosity was a predictor of information preference; no significant indirect or total effect was observed, and openness/intellect did not significantly predict state curiosity. This aligns with findings that openness/intellect significantly correlated with state curiosity for the Trivia/Bonus stimuli ($r = .20, p < .001$) and Character stimuli ($r = .19, p < .001$), but not the Reward-Outcome stimuli ($r = .06, p = .248$).

The second half of our predictions grouped under Hypothesis 1 concerned effects related to neuroticism and uncertainty intolerance. We hypothesized that these traits would positively predict seeking information for Reward-Outcome stimuli. However, neither neuroticism nor uncertainty intolerance significantly predicted seeking information, and Bayes Factors indicated evidence for the null (neuroticism $BF_{01} = 10.10$; uncertainty intolerance $BF_{01} = 3.96$). Second, we hypothesized that neuroticism and uncertainty intolerance would not positively predict seeking information for the remaining three stimulus sets.

These predictions were mostly supported. No significant positive effects were observed (Table 3, Models 10 and 11). For neuroticism, Bayes Factors found substantial evidence for the null for the Bonus stimuli ($BF_{01} = 8.13$), and anecdotal evidence for the null for the Trivia stimuli ($BF_{01} = 1.98$). While there was anecdotal evidence for the alternative hypothesis for the Character stimuli ($BF_{01} = 0.46$), this reflected the finding that neuroticism *negatively* predicted seeking information for this stimulus set. For uncertainty intolerance, Bayes Factors found evidence in support of a null for the Bonus ($M_{01} = 3.09$), Trivia ($M_{01} = 3.44$), and Character ($M_{01} = 2.99$) stimuli.⁷

Hypothesis 2. Our conceptual model specifies that information-seeking preferences should differ depending on how three key elements of the situation—positivity, negativity, and intellect—are perceived, which should, in turn, relate to the degree to which state emotions of joyous exploration, deprivation sensitivity, and uncertainty intolerance/anxiety and subsequent post-information emotions are transiently evoked. Consequently, we hypothesized that the different information-seeking stimulus sets would produce different situation and state emotion ratings by participants on average.

Figure 5 displays box plots for pre-information state ratings, post-information state ratings, and situation ratings across the different tasks. Repeated-measures ANOVAs found significant differences in all three ratings (Figure 5). Breaking down ratings by stimulus set, Bonferroni-adjusted Wilcoxon tests for mean differences are visualized in Figure 5. A summary of which hypotheses were (or were not) supported is included in Figure 5, Panel D. Supplementary Table 1 includes exact p -values for each comparison.

In line with our predictions, the Reward-Outcome stimuli were perceived to be more negative than both the Trivia⁸ ($p = .002$) and Character ($p < .001$) stimuli.

⁷ As shown in the correlation matrix of Figure 4, the only personality correlate of seeking Reward-Outcome information was conscientiousness ($r = .17$). Although we had not predicted this outcome, it converges with prior research that the *orderliness* aspect of conscientiousness, when combined with other indicators of obsessive-compulsive tendencies, predicts seeking information for this form of information (Bennett et al., 2020). However, given that this finding was

unpredicted and was not replicated in Study 2, we do not consider this result further.

⁸ For the trivia task, situation ratings referred to the whole task (Trivia and Bonus stimulus sets), so results should be considered to reflect attitudes toward both of these.

Similarly, the Reward-Outcome stimuli was perceived as less intellectually engaging than the Trivia and Character stimuli, both for the mean Intellect situation rating (Trivia $p < .001$; Character $p < .001$) and the adapted item from the Intellect sub-scale *the task provided an opportunity to learn about unusual ideas or points of view* (Trivia $p < .001$; Character $p < .001$). Further, participants reported higher positivity ($p < .001$) and higher ratings of state curiosity for the Trivia stimuli compared to the Reward-Outcome stimuli. Further, for both Trivia and Bonus stimuli, participants reported higher post-information ratings of interest, amazement, and surprise than for the Reward-Outcome stimuli (ps all $< .001$). This suggests that these stimulus sets evoke greater positive emotions, consistent with the possibility that they afford more instances of state joyous exploration, leading to exploration-oriented information seeking.

We expected that the Character stimuli would be rated similarly positively to the Trivia and Bonus stimuli. However, against predictions, situation ratings of positivity for the Character stimuli were the lowest of all tasks ($ps < .001$) and this pattern continued for the Character stimuli across the pre-information and post-information state ratings: although the Character stimuli produced low mean ratings of *bothered*, *need*, and *relief*—which we proposed signified aversive and deprivation-oriented responses to the unknown or, for relief, quiescence from having this uncertainty removed—it also produced the lowest mean ratings of putatively more positively-oriented emotions of curiosity, interest, pleasure, amazement, and surprise. Thus, it appeared that on average, participants felt little negativity or positivity toward the Character stimuli. This aligned with the optional feedback we obtained at the completion of each game: 32 participants reported boredom and related low positive emotions toward these stimuli (e.g., “Having absolutely no knowledge about Chinese characters the game was boring and not engaging”), compared to only six indicating higher positive emotions (e.g., “Interesting character choices - fun trying to guess what the words might be”). This lack of interest may provide an explanation why few participants sought information for these stimuli (Figure 3, Panel A).

Despite the average absence of positive feelings toward the Character stimuli, joyous exploration (and openness/intellect) predicted seeking information. Notably, positivity ratings for the Character stimuli correlated with joyous exploration ($r = .21, p < .001$) and openness/intellect ($r = .17, p = .001$), and so too did ratings of state curiosity for the Character stimuli (joyous exploration $r = .31, p < .001$; openness/intellect $r = .19, p < .001$). Thus, it seems that even though mean positive emotion ratings were low for the Character stimuli, participants higher in curiosity and openness/intellect tended to construe these stimuli as more engaging, which may have flow-on effects to decisions to seek information.

This is important because our theoretical model specifies that it is necessary for a situation to be perceived as having both Intellect and positivity to evoke states of joyous exploration and exploration-oriented information seeking. As predicted, reports of relief for the Reward-Outcome stimuli were higher than for the Trivia, Bonus, or Character stimuli ($ps < .001$). However, we predicted that the Reward-Outcome stimuli would have the lowest pleasure rating, but there was no significant difference between ratings for the Reward-Outcome stimuli and Trivia stimuli ($p > .999$), and pleasure ratings for the Character and Bonus stimuli were significantly lower than these ($ps < .001$). Finally, unlike the Character stimuli and against expectations, there were no significant differences in mean ratings of needing the information or being bothered by the lack of information for the Trivia stimuli compared to the Reward-Outcome stimuli (Figure 5, Panel B).

Study 1 Discussion

Study 1 assessed non-instrumental information-seeking preference, momentary emotions, and situation perception across four sets of stimuli. We found that preferences differed markedly across stimulus sets, both in proportion of choice responses and mean ratings over time (Figure 3). Further, participants rated their perceptions of and emotions toward the stimulus sets differently despite all including a choice for non-instrumental information. This suggests that these stimulus sets, each representing different situations, contain differing affordances and emotional responses that could partially drive differences in information seeking.

In this study, we tested predictions from our working model of information seeking, which featured two key motivations to seek information. The *exploration pathway* is more likely to be chosen by individuals higher in curiosity and openness/intellect and in situations evoking positive emotions and opportunities for intellectual engagement. The *safety pathway* is more likely to be chosen by individuals higher in uncertainty intolerance and neuroticism and in situations evoking more negative emotions. Several broad hypotheses were specified to test key elements of this model. Hypothesis 1 stated that personality traits (openness/intellect, neuroticism, curiosity, and uncertainty intolerance) would predict information-seeking preferences depending on the particular situation, and Hypothesis 2 stated that the information-seeking situations would be rated differently by participants on average.

Figure 5. Tests of Hypothesis 2. **A.** Mean situation ratings. **B.** Mean pre-information ratings. **C.** Mean post-information ratings. **D.** Summary of which predictions from Hypothesis 2 that were supported (green highlight and box outline) or not supported (no emphasis) by results depicted in panels A, B, and C.

Our results were supportive of an exploration pathway. For Hypothesis 1, openness/intellect and joyous exploration predicted choice preference for the Trivia, Bonus, and Character stimuli, but not the Reward-Outcome stimuli, whereas deprivation sensitivity predicted choice preference for all stimulus sets. These results held controlling for intelligence. Further, state curiosity was a statistical mediator in the relation between openness/intellect and information seeking, consistent with the possibility that individuals higher in openness/intellect tend to seek information due to feeling stronger instances of momentary curiosity. Note that, like all other results presented herein, the mediation analyses are conducted on cross-sectional data and don't provide direct causal evidence. Further, given the high intercorrelations between state curiosity and other state measures putatively assessing different emotions, this result should be considered highly tentative until the state measures can be adequately disentangled.

For Hypothesis 2, we found that situation perceptions of positivity were higher for the Trivia than Reward-Outcome stimuli, and that, although the Character

stimuli produced the lowest positivity ratings, individual differences in these ratings were associated with trait measures of joyous exploration and openness/intellect, in line with predictions from our model. Further, ratings of intellect were higher for the Trivia and Character than the Reward-Outcome stimuli. Findings related to state emotions were more variable and may reflect the failure to disentangle these constructs (see Supplementary Materials for more information).

For the safety pathway, results for situation perception were in the predicted direction: the Reward-Outcome stimuli were rated as lower in intellect and higher in negativity than other stimulus sets. This supports the idea that situations in which non-instrumental information is provided in advance of reward are perceived to evoke more negative emotions, and provide fewer possibilities for intellectual engagement, than tasks where the non-instrumental information is not linked to a reward but instead provides knowledge about the world more generally. Unexpectedly, however, neuroticism and uncertainty intolerance did not predict information seeking for the Reward-Outcome stimuli. Thus, we failed

to find support for key predictions within Hypothesis 1 related to the safety pathway.

Given the prevalence of the uncertainty-reduction explanation of information seeking in the literature, and previous studies relating uncertainty intolerance or neuroticism to information seeking (Bennett et al., 2020; Jach & Smillie, 2021), we considered whether elements of our experimental design could provide an alternative explanation for these results. One possibility is related to the number of trials before participants are given the choice to seek information. In the experimental design of Study 1, participants first completed 10 trials in which they were automatically shown all information without a choice. Following these no-choice trials, they completed 10 trials where they had a choice to seek information. Participants were told at the beginning of the reward-outcome paradigm that the coin flip provided a 50% chance of a reward on all trials. Thus, in an economic sense, there is no change in ambiguity throughout the task; only an unambiguous risk of 50% (Trautmann & van de Kuilen, 2015). However, there is a difference between being told this in the experiment instructions and physically observing it for oneself. Participants may be suspicious about the researcher's intentions and any possibility of deception; they may question whether a 50% chance of success is truthful. Thus, the payout structure of earlier trials may be perceived as more ambiguous even if it technically is not. For participants who are more intolerant of uncertainty, the higher perceived ambiguity in earlier trials may influence their decisions, whereas on later trials, having learnt through experience that a 50% chance of reward is accurate, there is no longer any ambiguity in their choice.

If this explanation holds, then we might expect that the relation between uncertainty intolerance and state reports of uncertainty to decline over time. Indeed, a multilevel model found support for this prediction, revealing a negative interaction between time and uncertainty intolerance when predicting state uncertainty ratings ($b = -0.005$, $t(8,282) = -2.34$, $p = .020$). This suggests it could be useful to assess personality correlates of Reward-Outcome information-seeking without first presenting the 10 no-choice trials. We therefore added such a version of this task to a separate ongoing project including many of the same measures in this study. This allowed us to explore whether uncertainty intolerance predicts information seeking for the shortened Reward-Outcome stimulus set, as well as divergent validity with information-seeking preference for the Trivia stimulus set.

Study 2

Method

Participants, Procedure, and Materials

Ethical approval was provided by the University of Melbourne Human Ethics Advisory Group (ID 2056503.2). Three hundred and eighty-six undergraduate students at an Australian university participated in this study for course credit. Participants were excluded for the same reasons as pre-registered for Experiment 1, except (1) timing for the BFAS questionnaire could not be assessed as it was not recorded, and (2) participants reported their age via their birth year and age range (e.g.,

"19-24") rather than their birth year and age in years, so we used a discrepancy between these responses to assess this criterion. Following exclusions, a final sample of $n = 316$ was obtained ($\text{mean}_{\text{age}} = 20.04$, $\text{SD}_{\text{age}} = 3.25$, 75% female, 24% male, 1% other).

Participants first completed the latter 10 trials of the Reward-Outcome stimulus set (i.e., only the trials wherein participants could choose to seek information). Because undergraduates participated for course credit, we were limited in possible monetary incentives, and so our reward-outcome information was knowledge of whether the participant had won an entry into a raffle to be drawn at the end of the academic term. All other elements were identical to Study 1.

Participants next completed the Trivia paradigm. This version differed slightly from Study 1: it included 25 questions, the final 5 of which allowed participants the choice to seek information. Questions were again drawn from an existing database (Fastrich et al., 2018), with questions overlapping partially from those included earlier in the manuscript. Due to time constraints and the focus on the Reward-Outcome stimulus set, we did not include the Character or Bonus stimuli.

Finally, participants completed DIAMONDS situation perception ratings (positivity, Negativity, Intellect, Duty) in response to the Reward-Outcome stimulus set, and personality trait measures assessed in Study 1 (Big 5, curiosity, and uncertainty intolerance). Several additional measures were included for different research projects and were not analyzed for the current study (see [manuscript withheld for blind review] for further details).

Data Analysis

Study 2 was not pre-registered as it followed up unexpected findings from Study 1. However, we aimed to be as consistent with Study 1 as possible, and data were analyzed with the same methods, using the same packages, performed once again in R Version 4.0.1 (R Core Team, 2020).

Results and Discussion

Table 4 shows descriptive statistics for variables of interest. Most variables, including information seeking for the Trivia and Reward-Outcome stimuli, demonstrated adequate reliability. Other descriptive statistics were also on par with what was observed in Study 1.

Figure 6, Panels A and B display proportion of information seeking and average choice preference over time, respectively. Similar to Study 1, the distribution of Reward-Outcome information preference was approximately bimodal; however, there appeared to be more variability in choice preference, and in Study 2 more participants chose to seek information than not seek information. Meanwhile, Panel B shows that information preferences for the Reward-Outcome stimuli dropped sharply over time, and statistical evidence supported the visual trend, with a multilevel model predicting Reward-Outcome information seeking by trial; $b = -0.04$, $t(2,843) = -16.96$, $p < .001$.

Figure 7 displays correlations between variables of interest. Consistent with Study 1, openness/intellect

and joyous exploration correlated significantly with seeking information for the Trivia stimuli but not the Reward-Outcome stimuli, whereas deprivation sensitivity correlated positively with seeking information in both stimulus sets. Further, uncertainty intolerance did not significantly correlate with Trivia information seeking. Neuroticism did not significantly correlate with Reward-Outcome information seeking, and though the correlation between uncertainty intolerance and Reward-Outcome information seeking was $r = .10$, this was also statistically non-significant ($p = .081$).

Table 5 displays latent variable regressions predicting information seeking for the Trivia and Reward-Outcome stimuli. Joyous exploration and openness/intellect significantly predicted information seeking for the Trivia stimuli but not the Reward-Outcome stimuli, and Bayes Factors found converging evidence predicting the null for Reward-Outcome information seeking (joyous exploration, $BF_{01} = 14.80$; openness/intellect, $BF_{01} = 17.38$). Meanwhile, deprivation sensitivity significantly predicted information seeking for both stimulus sets. These results replicated Study 1 and support the proposed exploration pathway.

Concerning evidence for the safety pathway, in support of our hypotheses, uncertainty intolerance significantly predicted Reward-Outcome information seeking, and uncertainty intolerance and neuroticism did not significantly predict Trivia information seeking (and Bayes Factors found substantial evidence for the null predicting Trivia information seeking: uncertainty intolerance $BF_{01} = 12.38$; neuroticism $BF_{01} = 11.97$). Further, when considering uncertainty intolerance and joyous exploration jointly (Table 5, Model 5), joyous exploration predicted Trivia information seeking but not

Reward-Outcome information seeking ($BF_{01} = 5.10$), and uncertainty intolerance predicted Reward-Outcome information seeking but not Trivia information seeking ($BF_{01} = 7.13$). Thus, after altering the Reward-Outcome task presented in our Study 1 by removing the first 10 no-choice trials, results do partially support our proposed safety pathway. However, contrary to our hypotheses, neuroticism did not significantly predict information seeking for the Reward-Outcome stimuli (Table 5, Model 5; $BF_{01} = 10.22$). Further, for uncertainty intolerance, Bayes Factors found weak and mixed evidence in predicting information seeking for Reward-Outcome stimuli: as a univariate predictor (Model 4) there was indeterminate evidence in support for the null despite a significant regression coefficient ($BF_{01} = 1.43$), and as a multivariate predictor (Model 6) there was indeterminate evidence in support of the alternative ($BF_{01} = 0.66$). Given only partial support across the set of hypotheses related to the safety pathway, we consider evidence for this pathway tentative but inconclusive, in contrast to the exploration pathway, where results were consistently in support of our hypotheses across both studies.

Table 4
Descriptive Statistics and Internal Consistencies for Study 2 Variables

Variable	ω	α	M	SD	Min	Max	Skew	Kurtosis
Info Seeking (Trivia)	.78	.77	0.59	0.34	0	1	-0.24	-1.17
Info Seeking (RO)	.90	.91	0.50	0.37	0	1	0.10	-1.49
Openness/Intellect	.57	.79	3.59	0.50	2.35	5	0.24	-0.13
Neuroticism	.76	.90	3.14	0.64	1	4.7	-0.05	-0.12
Extraversion	.67	.88	3.35	0.57	1.4	4.85	-0.04	0.39
Conscientiousness	.57	.83	3.18	0.52	1.8	4.65	-0.04	-0.12
Agreeableness	.72	.87	3.91	0.51	2.3	5	-0.26	-0.41
Uncertainty Intolerance	.84	.86	3.08	0.67	1.25	4.75	-0.16	-0.15
Joyous Exploration	.83	.83	3.83	0.63	2.12	5	-0.19	-0.42
Deprivation Sensitivity	.78	.85	3.40	0.75	1	5	-0.15	-0.03
pOsitivity RO	.73	-.61	2.85	0.73	1	5	0.34	0.13
Negativity RO	.86	.86	1.73	0.78	1	5	1.18	0.91
Intellect RO	.81	.81	1.74	0.80	1	4.33	1.08	0.45

Note. Omega reliability values (ω) are calculated in an identical fashion to Study 1.

Figure 6. Information choice preference for Study 2. (A) Number of participants who chose information. (B) Mean choice preference for information across trials.

Figure 7. Zero-order correlation matrix of information-seeking for the Trivia and Reward-Outcome stimulus sets, personality traits, and situation ratings (for the Reward-Outcome stimuli only). Unshaded correlations are statistically non-significant.

Table 5.
Latent Variable Regression Models for Study 2

model	Outcome	Predictor	Parameter Estimates						Fit Indices		
			β	95% CI		SE	Z	p	CFI	RMSEA [95% CI]	SRMR
1. Openness/ Intellect	RO	Openness/ Intellect	-0.01	[-0.14,	0.12]	0.06	-0.14	.888	.73	.07 [.07, .08]	.09
	Trivia	Openness/ Intellect	0.24	[0.10,	0.37]	0.07	3.49	< .001			
2. Joyous Exploration	RO	Joyous Exploration	0.04	[-0.09,	0.17]	0.07	0.58	.559	.97	.03 [.02, .04]	.05
	Trivia	Joyous Exploration	0.23	[0.10,	0.37]	0.07	3.43	.001			
3. Deprivation Sensitivity	RO	Deprivation Sensitivity	0.14	[0.01,	0.27]	0.07	2.17	.030	.98	.03 [.003, .04]	.04
	Trivia	Deprivation Sensitivity	0.16	[0.01,	0.30]	0.07	2.16	.031			
4. Uncertainty Intolerance	RO	Uncertainty Intolerance	0.13	[0.01,	0.25]	0.06	2.08	.038	.96	.03 [.02, .04]	.05
	Trivia	Uncertainty Intolerance	-0.01	[-0.14,	0.13]	0.07	-0.07	.940			
5. Neuroticism	RO	Neuroticism	-0.04	[-0.17,	0.09]	0.06	-0.62	.534	.88	.05 [.05, .06]	.06
	Trivia	Neuroticism	0.02	[-0.11,	0.15]	0.07	0.27	.788			
6. Joyous Exploration and Uncertainty Intolerance	RO	Uncertainty Intolerance	0.14	[0.02,	0.27]	0.06	2.28	.023	.93	.04 [.03, .05]	.06
	RO	Joyous Exploration	0.07	[-0.06,	0.20]	0.07	1.04	.297			
	Trivia	Uncertainty Intolerance	0.05	[-0.09,	0.19]	0.07	0.64	.519			
	Trivia	Joyous Exploration	0.24	[0.10,	0.38]	0.07	3.42	.001			

General Discussion

Despite nearly a century of theory and research suggesting that behavior is a function of both the person and the situation (Furr & Funder, 2021; Horstmann et al., 2020; Lewin, 1936; Sherman et al., 2015), researchers have rarely considered how person and situation factors may jointly drive variation in information seeking. In the current studies we sought to address this oversight by relating choice preference to personality traits across multiple information-seeking paradigms capturing different situational affordances. We were guided by a novel conceptual model of information seeking that includes different situation and person elements, and specifies two information-seeking pathways, one concerned with exploration and the other concerned with safety. Across two studies we found consistent support for the exploration pathway, and more tentative support for the safety pathway.

Results and Evidence for our Conceptual Model

Our first aim in this research was to assess whether information seeking varied across different experimental paradigms. We thus employed two predominant paradigms from the literature: a Reward-Outcome paradigm where participants could gain advance knowledge of a financial reward and a Trivia paradigm where information provided knowledge about the world but had no connection to an external reward. Further, we included two additional variations on the Trivia paradigm (Bonus and Character stimulus sets) that helped to rule out counter-explanations for choice preference. Across two experiments, we observed distinct information-seeking distributions between the stimulus sets (see Figures 3 and 6). Further, participants rated their emotions and perceptions of the situations differently across stimulus sets (Figure 5). Thus, despite both purportedly measuring non-instrumental information seeking, participants thought and acted differently in these different paradigms.

Our second aim in these studies was to evaluate our conceptual model that synthesized literature describing the interactions between personality and situation perception (Funder, 2006; Furr & Funder, 2021; Rauthmann et al., 2015) with information-seeking theory and research (Bennett et al., 2016; Bromberg-Martin & Hikosaka, 2009; Lau et al., 2020; Sharot & Sunstein, 2020a). Our theory specified two main pathways to seeking information. The exploration pathway is evoked in situations that afford positivity and intellectual engagement and when people feel stronger and/or more frequent states of interest-based curiosity; this is more likely to be experienced by people higher in trait curiosity and openness/intellect. Conversely, the safety pathway is evoked in situations that afford greater negativity and when people feel stronger and/or more frequent states of anxiety related to uncertainty; this is more likely to be experienced by people higher in trait uncertainty intolerance, neuroticism, and curiosity as a feeling of deprivation (Figure 1). Following the principles of this theory, we derived specific pre-registered hypotheses to test initial support (Table 1).

In line with our predictions, information from the Trivia, Bonus, and Character stimulus sets was chosen more often by individuals higher in trait curiosity and openness/intellect, even when controlling for intelligence, and these stimuli were perceived as more intellectually engaging, less negative, and (barring the Character stimuli) more positive than the Reward-Outcome stimuli. Further, in these stimulus sets, momentary reported curiosity correlated with trait curiosity, openness/intellect, and positivity/Intellect ratings; and the joyous exploration facet of trait curiosity related to greater pleasure and interest ratings after receiving information (Supplementary Materials, Section 3). Study 2 replicated personality-information seeking results in an independent sample. Thus, we found evidence consistent with an exploration pathway connected to curiosity across both studies.

In contrast, evidence for the safety pathway was mixed. In Study 1, as predicted, the Reward-Outcome stimuli were rated as more negative and less positive and intellectually engaging than the Trivia stimuli, and deprivation sensitivity successfully predicted Reward-Outcome information seeking. Unexpectedly, however, uncertainty intolerance and neuroticism did not significantly predict the choice to seek Reward-Outcome information. In Study 2 we removed the first 10 no-choice trials as we thought these could have reduced general task ambiguity; we then observed that uncertainty intolerance emerged as a significant predictor of Reward-Outcome information seeking, and deprivation sensitivity remained a predictor. However, neuroticism failed to predict information seeking for the Reward-Outcome stimuli, and Bayes Factors suggested that evidence for uncertainty intolerance predicting information seeking for the Reward-Outcome stimuli was inconclusive.

In summary, results partly support our working model but also suggest further refinements are necessary. Nevertheless, our findings clearly confirm our broad claim that non-instrumental information-seeking paradigms can be perceived differently and that preferences for information are different in different tasks and correlate

with different personality traits. Thus, the model's general principles of the importance of person and situation factors in eliciting motivated behavior were borne out in our empirical results.

Implications for the Safety Pathway

We found tentative and inconsistent evidence for the safety pathway across experiments. This could suggest that uncertainty reduction—or, at least, anxiety-related uncertainty reduction—is not as strong a motivator for reward-outcome information seeking as has been previously proposed in the literature. Indeed, the few studies that have included uncertainty intolerance alongside information-seeking paradigms also found mixed evidence: for example, Bennett et al. (2020) found an effect that fell short of significance after correcting for multiple comparisons, and Jach and Smillie (2021) found a significant correlation in Study 2, but not Study 1. If correct, this would necessitate altering or removing the safety pathway from our conceptual model.

However, it is perhaps more likely that we simply did not create the optimal context to elicit anxiety related to uncertainty. For example, in most reward-outcome experiments, participants passively wait for information to be revealed (e.g., Bennett et al., 2020), whereas in the current studies participants guessed an answer before making a choice to seek information. In this context, participants may have felt greater perceived agency and been more invested in learning the result as soon as possible to find out whether they chose correctly and “won” the trial, leading this motivation to trump others such as uncertainty-reduction. Intriguingly, a large proportion of participants always chose to see reward-outcome information (Figure 3; Figure 6), even though this preference was only weakly related to uncertainty intolerance and did not appear to relate to the exploration pathway. This suggests additional motivations could have predicted choice preference. One possibility is the desire to “savor” a good result, which has been proposed to motivate choices in some prior literature (Bromberg-Martin & Monosov, 2020; Charpentier et al., 2018; Igaya et al., 2016; Kobayashi et al., 2019). We observed that reported pleasure was higher for Reward-Outcome and Trivia stimuli than for Bonus and Character stimuli. As Reward-Outcome and Trivia stimuli are the only ones that permit participants to make guesses and then discover whether they were correct, this provides tentative support for savoring as a motivator of reward-outcome information seeking, and perhaps an additional motivator of Trivia information seeking, and could suggest a need to expand the conceptual model to incorporate savoring as an alternative motivator. To reduce perceived agency that could be increasing savoring motives at the expense of uncertainty reduction motives, guesses prior to information-seeking choice should be removed.

Further, compared to states of interest proposed to drive the exploration pathway, uncertainty about one's sense of safety may be difficult to elicit in an experiment, where potential threats to safety are far weaker than in the wider world. For example, as this manuscript is being written in 2021, one salient real-world threat is the COVID-19 virus, where uncertainties include whether oneself or one's family will be affected, when a vaccine will

be widely distributed, and when life will return to normal. This threat is orders of magnitude more serious than what is found in experiments, which may only include the threat of losing some small amount of money. This suggests the utility of more ecologically valid future study designs, where researchers could assess signs of anxiety-related information seeking via, for example, compulsive news checking. Alternatively, increasing the potential monetary loss per trial may make any threats to their monetary status more salient to participants.

Finally, we proposed that any sort of threat, including social threats, could drive information seeking to reduce uncertainty. Social threats can be readily assessed in experiments (e.g., through the Trier Social Stress Test or variations thereof; Allen et al., 2017) without raising significant ethical concerns and without a large financial costs. For example, if participants believe that their choices will be rated by a panel of other participants, they may wish to pay to know these ratings in advance even if they have no utility for the task.

Taken together, the tentative but inconsistent evidence across multiple studies, coupled with possible suggestions for why effects may not have emerged consistently, suggests that it is too early to say whether the safety pathway should be altered or removed from our conceptual model, and more broadly, whether the uncertainty-reduction explanation for information seeking is supported. Future studies should tackle this uncertainty with targeted attempts to address the issues as summarized above.

Multi-Disciplinary Implications of Results

Information Seeking Theory and Research

Our results indicate that information-seeking paradigms cannot be freely mixed and matched and expected to elicit the same motivations for behavior. Perhaps most striking is the reduction in exploration-oriented emotions and personality traits when employing reward-outcome paradigms. We suggested that this may occur in contexts that signal possible threats to individual safety, which includes possible loss of financial gain. Further, this is in line with similar research that finds rewards undermine intrinsic motivation (Murayama et al., 2010). This outcome has implications for researchers advocating an uncertainty-reduction explanation for information seeking, who often assess information seeking with reward-outcome experiments, or devise computational models that simulate reward-outcome experiments or include extrinsic rewards in model equations (Bennett et al., 2016, 2020; Caplin & Leahy, 2001a; Eliasz & Schotter, 2010; Wu, 1999). Such studies may simply be unlikely to elicit cognitive, emotional, or motivational affordances related to exploration, leading important pieces in the information-seeking puzzle to remain unnoticed. Thus, although consistency of experimental design is important when building cumulatively from prior research, the current research demonstrates how it is important to be wary of overgeneralizing results from a particular experiment to all instances of a given behavior. Our results suggest that it is possible to gain some insight into generalizability with

the use of multiple experimental paradigms coupled with situation perception or personality measures.

Curiosity Research

An information gap is defined as a specific question that one becomes aware of and recognizes that one does not know the answer to; it reflects a known lack of knowledge of a specific quantity (Golman & Loewenstein, 2018). Some theories of curiosity propose that it is necessary to specify an information gap before the feeling of deprivation-oriented curiosity is evoked (Golman & Loewenstein, 2018; Loewenstein, 1994). However, information seeking choices in the present studies were correlated with deprivation sensitivity for the Bonus and Character stimulus sets, neither of which contained a quantifiable information gap. This suggests that deprivation-oriented curiosity may not require an information gap.

Additionally, the fact that deprivation sensitivity was correlated positively both with joyous exploration (representing the exploration pathway) and uncertainty intolerance (representing the safety pathway) supports our framing of deprivation sensitivity as an interstitial facet comprising both positive emotions (e.g., enjoying learning) and negative emotions (e.g., finding the feeling of not knowing aversive). Deprivation sensitivity has been traditionally thought to reflect dopamine-mediated desire for information, in contrast to joyous exploration, which is proposed to reflect opioid-mediated liking of information (Litman, 2005). However, to our knowledge this proposition has never been directly tested in humans, and a more parsimonious explanation could be that both facets of curiosity involve dopaminergic and opioid activity (providing the motivation to explore and the rewarding feeling of gaining knowledge, respectively), but deprivation sensitivity is additionally accompanied by negative emotions that make the experience of seeking information somewhat unpleasant, even while it is desired. A suitable test could be a dopamine drug manipulation on one portion of the sample; this approach has been used successfully in prior research to test hypotheses relating dopamine to other personality traits (Mueller et al., 2014).

Theory of Openness/Intellect

Our results offer additional insight into a theory of the personality trait openness/intellect (DeYoung, 2013). This theory proposes that openness/intellect is grounded in greater sensitivity to the reward value of information, leading individuals higher in openness/intellect to explore and seek information. Until now openness/intellect has not been found to predict information seeking directly (Jach & Smillie, 2021; Smillie et al., 2021). However, most prior studies employed reward-outcome paradigms which, as we show here, do not appear to afford exploration-oriented information seeking. Our results suggest a link between the exploration pathway and openness/intellect via curiosity (particularly joyous exploration): specifically, openness/intellect is related to exploration-motivated information seeking, but not safety-motivated information seeking. This aligns with the perspective that people higher in openness/intellect feel

that uncertainty is enticing, and see many possibilities from engaging with the unknown (DeYoung, 2013).

Issues of Causality and our Model

By varying the experimental context, we observed changes in situation perceptions, emotions, and information seeking. Thus, our findings provide some initial evidence of the broader causal impact of the situation on motivations to seek non-instrumental information. More specifically, we proposed a conceptual model to begin to understand precisely how person and situation factors may relate to information seeking (Figure 1). This included a suggested causal direction whereby personality traits modulate the perceived situation, situation perceptions lead to state emotions, state emotions lead to goals for exploration and/or safety, these goals spur information seeking, and receipt of information induces post-information emotions. From this model we derived several specific hypotheses, many of which were supported by study results. This provides evidence that is consistent with our model. However, unlike evidence for our broad proposal, our studies cannot provide direct evidence for many of the specific directional paths described in our conceptual model, including proposed mediations (Bullock et al., 2010). Indeed, although we think our model is useful, like all models, it is likely to be wrong (Box, 1976). For example, there may be strong bidirectional and circular pathways between situation perceptions and emotions, whereby feeling a certain emotion (e.g., fear) makes it more likely to perceive the situation in certain ways (e.g., interpret someone's comment as aggressive), which may induce further negative emotions (Lewis, 2005). It may also be challenging to separate reported emotions from reported situation perceptions, given their substantial conceptual overlap (Horstmann et al., 2020; Horstmann & Ziegler, 2019). Furthermore, there are doubtless other important variables to add to the model, such as alternative motivations (e.g., savoring, discussed earlier) or different elements of the perceived situation or different emotions (described in the Limitations section following). Accordingly, we think of our model less as a rigid set of laws and more as a helpful tool to frame our initial hypotheses, to think more clearly about various possible causal pathways, and to guide future research.

Limitations and Future Directions

Considerations of participant fatigue and budget limitations influenced the number of trials we could include in our paradigms: for example, Study 1 included 20 trials per stimulus set, 10 of which included a choice to seek information. Although reliability was high in each stimulus set, indicating consistent preferences over trials, longer experiments would provide more stable estimates of mean effects and changes over time. Further, the Trivia and Reward-Outcome stimulus sets varied across a number of dimensions, and these differences could provide alternative explanations for differences in choice preference. However, to account for the limitations in experimental control, we developed two variations of the Trivia paradigm—the Bonus and Character stimulus sets—the latter of which was embedded within the Coin-Flip game alongside the Reward-Outcome stimuli. This

provides greater assurance that peripheral elements are not the central drivers of observed differences between stimulus sets. Despite this, future research would benefit from comparing a range of paradigms with only small changes between them and observing whether differences in emotions, perceptions, and personality trait correlates of information seeking emerge across paradigms.

It was difficult to gauge how well states of joyous exploration and anxiety related to information seeking because the items chosen to represent these states were intercorrelated to such an extent that independent effects could not be effectively disentangled. The post-information emotions were challenging to distinguish for the same reason, forestalling detailed investigation of how information was received across the stimulus sets. This suggests that words to describe state emotions may not have been chosen optimally, and/or participants may not be willing or able to make fine-grained distinctions between specific emotions. This has implications for the choice of emotion words in studies, especially when they are measured with single items. It also demonstrates the value of including trait measures, which have typically been through many stages of validation and can provide more fine-grained insight into the different motivators. In the future, investigations of emotions and information seeking should improve assessment of state emotions, perhaps by creating latent measures across several different emotion items. Doing so might allow for more targeted tests of different parts of our conceptual model. For example, a study could assess how the connections between pre-information emotions, information seeking, and post-information emotions shift over the course of an experiment, and how this may be moderated by personality traits. This would be particularly effective with an increased number of trials per stimulus set.

In Study 1, the Trivia paradigm was completed before the Coin Flip paradigm, whereas in Study 2, the Coin Flip paradigm was completed before the Trivia paradigm. This could have induced unforeseen order effects that might partially account for differences in results. Some concern can be ameliorated by observing that in Study 1, patterns of effects for the Trivia and Bonus stimuli were similar to patterns of effects for the Character stimuli, which was conceptually related to the exploration path but occurred at the opposite end of the survey. But counterbalancing the occurrence of different stimulus sets would be valuable for future research, and it may also help to disentangle one open question in particular: whether the low rate of information seeking for the Character condition reflected a stimulus-specific effect (e.g., decontextualized information about a language one has no knowledge of is less interesting) or an experiment-level effect (e.g., fatigue following completing the prior elements of the study). Similarly, although personality items were randomized within a block, they occurred at a similar point in the survey for each participant (in Study 1, between the Trivia and Coin Flip paradigm; in Study 2, following both paradigms). Counterbalancing the appearance of personality surveys could forestall concerns that taking part in an experimental paradigm could have flow-on effects to survey ratings.

Finally, the current studies examined the roles that both the person and the situation play in behaviors

such as information seeking and, via our conceptual model, provided a starting point for future investigations of these elements. We assessed choice preference across four stimulus sets and multiple personality traits, emotions, and situational affordances theorized to influence particular motivations. Importantly, this represents a small snapshot of possible situations: different paradigms might afford new motivations and relate to other personality traits, in line with the perspective that any element providing affective or cognitive value could motivate non-instrumental information seeking (Sharot & Sunstein, 2020). Future research can draw from our framework to propose and investigate these.

Conclusion

This research provides a proof of concept that people display context-dependent patterns of preferences for non-instrumental information and demonstrates how these preferences meaningfully map to particular personality traits. We found evidence consistent with an exploration pathway linked to curiosity, and some tentative evidence consistent with a safety pathway linked to uncertainty intolerance. We have demonstrated the value in jointly considering person and situation factors to understand the internal processes driving choice behavior, and thus, our results speak to the possibilities of interdisciplinary synthesis in understanding complex cognitive-emotional processes that motivate information-seeking.

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