# Fenneman, Frankenhuis, and Todd's (2022) review of formal impulsivity models: Implications for theory and measures of impulsivity

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

## Acknowledgements

This research was supported by the Monash-Warwick Alliance Accelerator Fund.

## Abstract

In Fenneman, Frankenhuis, and Todd's (2022) review of theories and integrated impulsivity model, the authors distinguish between information impulsivity (i.e., acting without considering consequences) and temporal impulsivity (i.e., the tendency to pick sooner outcomes over later ones). The authors find that both types of impulsivity can be adaptive in different contexts. For example, when individuals experience scarcity of resources or when they are close to a minimum level of reserves (critical threshold). In this commentary, we extend their findings to a discussion about the measurement of impulsivity. We argue that a common method for measuring temporal impulsivity in which people make decisions between outcomes that are spaced out in time (intertemporal choice tasks), puts individuals in a specific context that is unlikely to generalize well to other situations. Furthermore, trait measures of impulsivity may only be modestly informative about future impulsive behavior because they largely abstract away from important context. To address these issues, we advocate for the development of dynamic measures of the two types of impulsivity. We argue that measuring temporal impulsivity in naturalistic contexts with varying environmental and state parameters could provide insight into whether individuals (i.e., humans and non-human animals) react to environmental changes adaptively, while trait measures of impulsivity more generally should collect and provide more contextual information. Dynamic measurement of different types of impulsivity will also allow for more discussion about adaptive impulsive responses in different contexts, which could help combat the stigmatization of various disorders associated with impulsivity.

**Public Significance Statement**

The target article offers an integrated account of situations and conditions where impulsive behavior is adaptive. We extend these findings by calling for dynamic and rich measurement tools of impulsivity that manipulate or take into consideration state and environmental influences. Increased attention to the adaptiveness of different aspects of impulsivity will allow for the de-stigmatization of behaviors and disorders typically associated with it.

***keywords****: impulsivity, measurement, intertemporal choice, time preferences; delay discounting*

# Fenneman, Frankenhuis, and Todd's (2022) review of formal impulsivity models: Implications for theory and measures of impulsivity

In their recent article, Fenneman, Frankenhuis, and Todd (2022) (henceforth: FFT) take on the ambitious task of integrating and reviewing a large body of existing research on formal models of impulsivity. Covering several diverse fields of inquiry, including economics, psychology, biology, and management, the authors develop a conceptual framework of existing computational models of impulsivity. With this framework at hand, FFT set out to identify and compare common features, results, and implications of multiple distinct accounts of impulsive behavior. Considering the multifaceted nature of impulsivity in the existing literature (Cyders, 2015; Cyders & Coskunpinar, 2011; Stevens, 2017), FFT focused on two types of impulsivity: *information impulsivity*, which refers to actions without full consideration of consequences and outcomes, and *temporal impulsivity*, which corresponds to the tendency to pick sooner outcomes over later ones. To summarize their insights, FFT identified a range of regularities by which objects (e.g., resources, delays, individual's current state known as their phenotype), beliefs (i.e., uncertain estimates concerning objects), and relations (i.e., causal relations between objects and/or beliefs) determine the adaptive level of impulsivity (information and temporal) for a decision-maker. The main result of FFT's analysis was that the optimal level of impulsivity is highly context-dependent. Thus, even high levels of temporal and information impulsivity may be adaptive under specific, but ecologically plausible, conditions (in line with e.g., Dickman, 1990; Gullo & Dawe, 2008; Perales et al., 2009; Stevens & Stephens, 2010).

The implications of FFT's insights are potentially profound. If we accept that an individual's impulsivity (be it information or temporal) could reasonably change from one situation to another, then this changeability raises questions about the validity of commonly used measures of the construct as a stable individual characteristic. More specifically, an

assumption underlying many existing measures is that impulsivity is a trait-like stable disposition that characterizes a person's attitudes towards information and time. In light of FFT's conclusion, new questions about the validity of such measures arise. Do results from current behavioral measures of impulsivity generalize to corresponding real-world behaviors? How do we know to which conditions our trait measures of impulsivity will generalize? FFT's contribution provides some answers to these questions. By taking an interdisciplinary approach to integrating existing models of impulsivity, FFT ultimately provided a potential taxonomy for measuring context-dependent impulsivity.

In this commentary, we extend the discussion of the potential implications of FFT's analysis. Specifically, we offer two arguments. First, we consider implications for the *intertemporal choice task*, a common temporal impulsivity measure, based on people's choices between outcomes that occur at different time points. To illustrate, the most commonly used, and arguably simplest intertemporal choice task is often referred to as "money earlier or later" (MEL). In this task, people choose, for instance, whether they would prefer to receive $100 today or $150 in three months (Ericson & Laibson, 2019). Building on the conclusions presented by FFT, we propose that intertemporal choice tasks of this kind do not generalize well to real-life impulsive behaviors because of two reasons. First, the intertemporal choice task lacks conceptual fit with how impulsivity is defined in the research literature. Second, as FFT showed in their analysis, the adaptiveness of impulsivity can vary. As such, we may expect people to vary in temporal impulsivity, across time, contexts, and modalities (i.e., types of outcomes). The relevant features of an individual's state and environment, as identified by FFT, are difficult to manipulate in standard intertemporal choice tasks, which limits the tasks' usefulness for measuring individual-level differences in trait temporal impulsivity.

For our second general argument, we posit that the current behavioral and self-report measures of trait impulsivity are unable to capture people's dispositions accurately because these measures are unable to dissociate baseline dispositions from state and environmental influences. Therefore, current measures have limited predictive value in everyday decisions and behaviors due to the context-dependent nature of impulsive decision making. To address this issue, we recommend that self-report measures should collect more background data and provide richer results, while behavioral measures should incorporate dynamicity (i.e., implement state and environmental changes). We provide illustrations regarding how to accomplish these aims. FFT's review provides further evidence that current measures of the various dimensions of trait impulsivity may benefit from more dynamicity. That is, measures of various types of impulsivity may better inform theories and computational models of decision making if they are able to capture how individuals respond to changes in their environment/state.

In the following two sections, we develop each of these arguments in more detail. We then put forth recommendations for future research and discuss the wider implications of the context-dependence of temporal and information impulsivity.

## Generalizability of Intertemporal Choice Tasks—Or a Lack Thereof

In this section, we discuss the validity and generalizability of intertemporal choice tasks, where individuals choose between outcomes occurring at different time points. We begin by summarizing some of FFT's insights into the relationship between context and the adaptiveness of temporal and information impulsivity, and relate their insights to intertemporal choice tasks.

To illustrate their conceptual framework, FFT introduced a running example of a job search scenario. In this scenario, a decision-maker must decide whether to accept the next

available job or prolong their search for a more suitable alternative. This type of everyday choice astutely captures a typical situation in which temporal and information impulsivity may impact the long-term welfare of an individual. FFT showed that the exact level of optimal temporal and information impulsivity depends on the individual's phenotypic state and the properties of the environment. Further, information impulsivity and temporal impulsivity do not have to be adaptive or maladaptive in the same situation. A more informationally impulsive individual may fail to sample enough information about the available alternatives and fail to pick the more valuable option (here, a better job). For temporal impulsivity, the same person may choose the immediately available job, missing out on a better offer that becomes available in the near future. In contrast, in an environment with high scarcity (here, fewer available jobs), an individual with low temporal and information impulsivity may incur high costs by sampling information for too long while they could be working, or they may wait too long for high-quality jobs that will never materialize.

When researchers want to infer what individuals with different predispositions will do in situations where temporal or information impulsivity matters (e.g., job search, reactions to cravings, interpersonal conflict, sexual behavior), they understandably might try to measure individual differences in impulsivity. Candidate measures could include trait scales such as the Barratt Impulsiveness Scale (BIS-11; Patton et al., 1995; Stanford et al., 2009) or the UPPS-P impulsivity scale (Cyders et al., 2014; Whiteside & Lynam, 2001). As an alternative to self-reported dispositions, researchers may use intertemporal choice tasks (see e.g., Baumann & Odum, 2012; Bickel & Marsch, 2001; Chabris et al., 2010; Madden et al., 2004; Read, 2004; Stevens & Stephens, 2010; Wiers et al., 2010). There are other relevant measures for adjacent constructs, such as the Implicit Association Test, which relates to how attitudes spontaneously affect behavior (Greenwald et al., 1998; Nosek et al., 2011). Much of our

discussion in the current work will have implications for those literatures as well, but our discussion will focus on behavioral and self-report measures of impulsivity.

Despite the widespread attention intertemporal choice receives in psychological and decision research (see e.g., Amlung et al., 2017; Bickel & Johnson, 2003; Chabris et al., 2010; Green & Myerson, 2013; Madden & Bickel, 2010; Rung & Madden, 2018; Stevens, 2017), there is little empirical support for the generalizability of its measurements to other types of behavior (for an overview, see Bailey et al., 2021). If anything, it appears that measurements of steep discount rates (a measure of how strongly individuals devalue future outcomes) correlate only modestly with various pathological behaviors and disorders (Amlung et al., 2017, 2019; Barker et al., 2015; Strickland et al., 2021). Steep discounting is also found among those suffering from disorders that should not implicate this construct, such as depression (Pulcu et al., 2014). As of yet, it is not clear whether high temporal impulsivity is an underlying factor for most of these disorders, or whether these pathologies contribute to the individual being in a state and/or environment that encourages steep discounting. Certainly, FFT's analysis did not rule out the latter as a possibility.

**Conceptual Overlap Between General Impulsivity and Temporal Impulsivity**

In this subsection, we discuss why intertemporal choice measurements, despite the amount of research interest, do not predict real-world impulsive behavior well.

Various researchers refer to the tendency to prefer smaller-sooner rewards (here, temporal impulsivity) as "choice impulsivity" (Broos et al., 2012; Hamilton et al., 2015; for a critique of this usage, see Cyders, 2015). Although choice impulsivity initially seems like a broad concept, it is almost exclusively used to describe intertemporal choice preferences, in particular, delay discounting. Still, the term "impulsivity" in the scientific literature refers to a wide variety of behaviors and tendencies, many of which are seemingly unrelated to delay

discounting and to one another. Among other things, impulsivity can refer to disinhibition in the motor and cognitive domains, swift response times, a lack of deliberation, a preference for risk, a tendency not to delay gratification, and a preference for earlier rewards over later ones. The frequent use of choice impulsivity to refer to delay discounting implies that the psychological literature has resigned itself to the idea that delay discounting is how impulsivity manifests in choice behavior. To avoid confusion in this discussion, we will stick to FFT's usage of temporal and information impulsivity and interface with the broader literature by referring to "general impulsivity".

Recently, Van Baal and colleagues (2022) have argued that temporal impulsivity measured through intertemporal choice tasks is conceptually orthogonal to general impulsivity. For general impulsivity, they use a common definition adapted from Moeller and colleagues (2001, p. 1784), that it is a predisposition to react to stimuli without considering the consequences. This definition is similar to how FFT define information impulsivity. FFT's findings contribute to this discussion because they showed that information impulsivity and temporal impulsivity are not only conceptually different, but they are also functionally different; information impulsivity and temporal impulsivity are adaptive under different circumstances.

The implication of this conceptual and functional dissociation between the types of impulsivity is that high information impulsivity (and thus the conceptually similar general impulsivity) may equally lead to behaviors that are indicative of low or high temporal impulsivity, and indeed, high temporal impulsivity may also lead to behaviors that are indicative of low or high information impulsivity. In other words, if an individual carefully seeks information, deliberates their decision, and consults with others about it, this does not necessarily tell us anything about whether their resulting decision is going to be future-oriented or not (e.g., one might decide after many calculations, deliberations, and

conversations with financial advisors (low information/general impulsivity) that it is time, finally, to enjoy all the money one has saved for retirement (high temporal impulsivity)).

To illustrate this point Van Baal, Walasek, et al. (2022) turn to (among other sources) the evidence that people can be impulsively "hyperopic" (i.e., they have low temporal impulsivity but high information impulsivity). Hyperopic people tend to forego immediate rewards for future ones and often regret doing so (Kivetz & Keinan, 2009). The term *hyperopia* contrasts with *myopia*, which is often used to indicate excessive discounting of future outcomes. That is, a hyperopic individual's habitual or intuitive response is to prioritize future needs or desires, and thereby hyperopic individuals rarely enjoy the present. To put it into FFT's terms, a hyperopic individual might not sample enough information in a job search scenario and choose the future-oriented option—they will wait for a better option to materialize. Though it is not the focus of our current discussion, it is worth noting we can bring to bear other theories here: The Theory of Planned Behaviour postulates that automatic attitudes can affect behavior without involving reasoning, especially in contexts that promote spontaneous behavior (Ajzen, 1991; Ajzen & Kruglanski, 2019). Thus, a preference for earlier rewards over later ones (high temporal impulsivity) is not a valid measure of a tendency to act without regard to consequences (general impulsivity) because there is little conceptual overlap between these two types of impulsivity.

What could be the reason why researchers tend to equate temporal and general "impulsivity"? One possibility is that researchers implicitly assume that people who act in a present-oriented fashion do so without properly deliberating or searching for information (see also, Loewenstein, 2018). Such an assumption highlights the differences in cultural frames and norms of academics and the general population. Economists, behavioral economists, and even psychologists often describe present-oriented choices as problematic, whereas folk conceptions of acceptable or rational behavior in this domain are arguably more permissive.

As a consequence, the temporal impulsivity literature is rife with negative normative language of present-orientation (impatience, inability to delay gratification; Frankenhuis & Nettle, 2020).

As Van Baal, Walasek, et al., (2022) allude, determining ex-post whether a behavior is (temporally or informationally) impulsive is difficult because one needs access to the deliberative process of the individual. Such access often even exceeds the individual's own introspective abilities, especially after the fact (Berger et al., 2016; Nisbett & Wilson, 1977; Pronin, 2009). Thus, it is plausible that the extent to which some behaviors are dubbed as impulsive, both in everyday life and in the research literature, is dependent on social norms. That is, if an action seems to people as irrational, or otherwise imprudent, then it is often assumed that it occurred on impulse. For example, in some places, negotiating a price for a house is regarded as "impulsive" if it takes less than a month, while in other places it is normal to end the negotiation within a day (which relates to FFT's analysis and conclusions about the adaptiveness of temporal and information impulsivity under scarcity and competition, for instance). The result of this analysis on why certain behaviors tend to receive the impulsivity label further reinforces the idea that time preferences (or here temporal impulsivity) ought not to be taken to mean general impulsivity. And that high temporal impulsivity is not the same as a lack of consideration or deliberation on the part of the decision-maker.

The functional dissociation of temporal and information impulsivity also implies that even if we knew how a decision-maker's temporal impulsivity changes for different kinds of outcomes, contexts, and at different time points, we still could not predict real-world "impulsive" behavior well. Especially for complex and ostensibly "impulsive" behaviors, such as gambling, temporal impulsivity may only constitute a small part of the phenomenon. The decision-maker's tendency toward information impulsivity or risk aversion might be

pushing them in the opposite direction, and it is difficult to disentangle the relevant cognitive processes. Gamblers are more likely to be present-oriented than the general population (Ioannidis et al., 2019). Nevertheless, an individual might gamble precisely because of future-oriented considerations. For instance, a parent in poverty might judge winning the lottery to be the best chance for them to send their children to college. This behavior is not temporally impulsive, given that the motivation (or analogously, the consumption intention) for the behavior is not a present-oriented one. Thus, given that temporal impulsivity often only constitutes a small part of behaviors and choices associated with general impulsivity, equating temporal impulsivity with "choice impulsivity" appears reductive.

We conclude, then, that one reason for the poor generalizability of temporal impulsivity measurements is the lack of conceptual overlap between general impulsivity and temporal impulsivity. Another reason, we have argued, is that there are important functional differences between information impulsivity and temporal impulsivity. Temporal impulsivity also typically only makes up a small part of real-world behaviors involving time, limiting this construct's explanatory power. Taken together with the evidence that the various dimensions of the broader concept of impulsivity are largely unrelated (De Wit, 2009) and the modest correlations between temporal impulsivity measurements and self-reported impulsivity scale measurements (Cyders & Coskunpinar, 2011), our arguments reinforce calls to investigate the ways to separate temporal impulsivity from general impulsivity (Broos et al., 2012; Caswell et al., 2015; Cyders, 2015; Sharma et al., 2014; Stevens, 2017). Or, to consider not referring to this "general" concept of impulsivity as a psychological construct altogether (Strickland & Johnson, 2020), and instead favor more specific terminology.

## Changeability of Temporal Impulsivity Across Time, Modality, and Context

Aside from conceptual and functional issues, the generalizability of intertemporal choice task to real-life behavior rests on whether people have stable temporal impulsivity over *time*, *modality*, and *context*. That is, the predictive value of the measurement should hold at a later time, for different kinds of outcomes (e.g., for chocolate bars *and* yoga retreats), and in different contexts (e.g., on the day salary is paid out *and* after an expensive holiday). Intertemporal choice task measurements, we contend, are unlikely to generalize because the measurements taken do not satisfy these conditions.

### Changeability of Temporal Impulsivity Across Modalities

If a decision-maker has varying temporal impulsivity for different modalities (i.e., they have different preferences for one type of outcome than for another), or for cross-modal choices (e.g., a better fridge now or a holiday later, see Cubitt et al., 2018), then measuring their temporal impulsivity for monetary rewards would likely predict behavior in many other domains poorly (Weatherly et al., 2010; Weatherly & Terrell, 2010). For example, people exhibit different temporal impulsivity for education and careers than for food and drink—many people spend decades educating themselves to be able to do the job they want but many of those same people might pay for sped-up deliveries of parcels (Loewenstein, 2018). This pattern is also reflected in research on temporal impulsivity for multiple modalities; temporal impulsivity measurements for different modalities tend to correlate moderately, depending on the modalities chosen (Odum et al., 2020; Weatherly et al., 2010).

Another problem reducing the generalizability of intertemporal choice measures is that it is often unclear in everyday life what the future, discountable "rewards" are. In the partner selection example, is the lifetime utility garnered from a relationship the reward in question? What motivates the decision-maker more: the initial connection and compatibility

or the likelihood of healthy offspring and long-term opportunities for growth and learning from each other in the relationship (this matters because sequences are discounted differently from single rewards; Loewenstein & Prelec, 1993; Loewenstein & Sicherman, 1991; Magen et al., 2008; Radu et al., 2011)? Or perhaps it is other fitness-related characteristics, such as the stability of their income, wealth, emotional stability, and healthy habits? Yet, perhaps the reward that is subject to temporal impulsivity is more holistic: Maybe it is the amount of anticipated increase in satisfaction or the sense of purpose and meaning in life the partner helps the individual to attain. There are also negative aspects: Relational struggles, the possibility of rejection, the possibility of a duty of care for the in-laws, and the uncertainty surrounding task division in the household. How are these negative aspects discounted (losses are discounted differently to gains; Abdellaoui et al., 2010)? All these aspects are presumably valued to varying degrees by individuals, and some individuals may discount different facets to different degrees too (more on this in the next section). And as we have discussed, it stands to reason that different modalities, and thus also different aspects of rewards, are likely subject to different levels of temporal impulsivity. In turn, generalizability of temporal impulsivity measurements to real-life decisions will decrease as the complexity of these decisions increases.

### Changeability of Temporal Impulsivity Over Time and Between Contexts

The generalizability of temporal impulsivity measurements depends on temporal stability as well as stability across contexts. These are intricately tied, as the context at time $t_1$ is inevitably different from the context at time $t_2$. As such, we will discuss these points together.

If someone's temporal impulsivity varies—today they prefer later rewards, tomorrow they prefer sooner ones—measuring their temporal impulsivity today does not accurately

predict future behavior. There is evidence that temporal impulsivity can be moderately stable over time, but unstable when other factors are considered. Researchers have concluded that there are both state and trait components to discounting future rewards (Odum et al., 2020; Reynolds & Schiffbauer, 2004; Skrynka & Vincent, 2019), which is likely subject to individual differences. Variables such as mood, deliberation, hunger, social norms, and even time of day can influence temporal impulsivity and concomitant behaviors (Bulley & Gullo, 2017; Bulley & Schacter, 2020; van Baal, Moskovsky, et al., 2022).

When important variables change in the decision-maker's context—that is, their phenotypic state or environment shifts—it may alter the decision-maker's temporal impulsivity (as indeed FFT argued may be the case). We could imagine that if we measure a decision-maker's temporal impulsivity for money while they still have a job, it will likely be different from when they are between jobs (i.e., more future-oriented when they have a job, but more present-oriented when between jobs). This difference is due to the individual's phenotypic reserves; it is much easier to reach a *critical threshold* when one does not have a job, when one is evicted, in bad health, or loses their romantic partner or a loved one. As FFT suggested, temporal impulsivity is adaptive when phenotypic reserves are low. It can be much more tempting to get money quickly, and as such, one may get a pay-day loan, try their luck at the casino, or conduct illegal activities.

To change people's temporal impulsivity, the situation does not need to be so drastic, however. Even unimportant variables can influence people's preferences in intertemporal choice tasks. Slight changes to the context that are unimportant to the choice can cause large shifts in behavior (see e.g., delay/speed-up asymmetry Loewenstein & Prelec, 1992; the hidden zero effect, Magen et al., 2008; Naudé et al., 2018).

These conditions for the generalizability of temporal impulsivity measurements elucidate why intertemporal choice tasks often will not generalize to decisions they are intended to model (for a discussion of the usefulness of delay discounting measures in a clinical setting, see Bailey et al., 2021). Intertemporal choice tasks provide a measurement made over a short period (usually less than an hour), choices are usually made in a modality unfamiliar to most (trading off sure amounts of money now versus later), participants are often brought to an unfamiliar controlled environment (a lab), while there is often little knowledge of the participants' circumstances. Note that satisfying all three conditions (i.e., stability over time, reliability across modalities and contexts) to a sufficient degree is necessary to have an intertemporal choice measurement that generalizes to real-world behavior. If an individual's temporal impulsivity is stable over time and we know how they respond to different contexts, but their temporal impulsivity is not reliable across modalities, we could have a reliable measurement of their temporal impulsivity for monetary rewards, but not for most other types of rewards, such as food, health, or romantic partners.

The problem with the assumption that temporal impulsivity is stable across time, modality, and context is compounded by the fact that intertemporal choice tasks are not good analogs of real-life situations. Rarely will people encounter a situation where they can make a riskless investment by forgoing amount *A* now and as a result gain a larger amount *B* later (the future is inherently risky, see Konstantinidis et al., 2020). Moreover, in intertemporal choice tasks, researchers generally do not vary endowment, state, and environmental parameters to see how participants respond. Instead, they attempt to make the task context-less to measure individual differences of a trait that is inherently highly context-dependent. Thus, when researchers administer an intertemporal choice task (such as with monetary amounts) that is seemingly context-free, we are not capturing a neutral or baseline response—we are measuring participants' responses to a task where the naturalistic context has been

substituted for an unrealistic one. As a result, different measurements may be obtained with only minor perturbations to the design or the attention of the participant (Lempert & Phelps, 2016). This malleability ultimately reduces the generalizability of standard methods used to assess a person's degree of temporal impulsivity (for a similar conclusion, see Shiffrin, 2022).

If intertemporal choice tasks are not well-designed for uncovering drivers of everyday choice where impulsivity matters, then why are they so widespread in psychology and behavioral economics? One possibility is that it is partly due to the elegant and parsimonious descriptive choice models that have sprouted from the concept of intertemporal choice, most notably the discounted utility model (Samuelson, 1937) and the hyperbolic discounting model (Ainslie, 1975; Mazur, 1987; for an overview of models, see He et al., 2022). These models are useful tools for understanding behavior in a system with a lot of uncertainty (humans interacting with the world) and provide a psychologically plausible model for how time is factored into decisions (Ballard et al., 2023; Bickel & Johnson, 2003; Lempert et al., 2019). The MEL task is simply the easiest way to provide data for fitting these functions. Here we can refer to FFT's valuable discussion of the importance of formal models in the study of impulsivity. We agree with them, and many others (Ballard et al., 2023; He et al., 2022; Walasek, 2016), that a formal definition of a system involving inputs, underlying processes, and outputs provides an important solution to the otherwise vague and imprecise verbal models expressed in natural language. And, as FFT noted, not all formal models must be evaluated against empirical data to prove their usefulness. As a conceptual aid for understanding decision making the usefulness of delay discounting models is undisputed. However, as we have discussed, it turns out that fitting delay discounting models to data and using parameter estimates to assess individual differences or to predict behavior outside the laboratory is of limited use.

An additional concern is that if one's objective is to measure, quantify, and parameterize individual differences in some dimension of impulsivity, a number of simplifications need to be made concerning (a) data that can be reliably collected about a person's tendencies and preferences (i.e., operationalization); and (b) the complexity of the formal model that can be fitted to such data. The simplification present in intertemporal choice tasks strips the everyday intertemporal choice of features that in FFT's analysis emerged as powerful determinants of whether impulsive behavior is adaptive or not. The notion of interruptions that can change the reward structure over time, the individual choice-relevant resources, and costly sample-based learning about cues underlying different rewards, are among many factors that could contribute to the psychological process of "impulsive" choice, and yet they are ignored in typical applications of intertemporal choice tasks. If researchers wish to model human decision making in a simplified context, using intertemporal choice tasks can be a useful approach. But if the goal is to make inferences about an individual's everyday decision making, then intertemporal choice tasks are unlikely to be very useful. Frey et al. (2017) reach a similar conclusion for behavioral measures of risk by showing that general risk preferences only correlate weakly with behavioral tasks such as choosing between monetary lotteries.

Taken together, building on the conclusions of FFT, who showed that the adaptiveness of information impulsivity and temporal impulsivity is highly context-dependent, we argue that standard intertemporal choice tasks are unreliable tools for measuring trait impulsivity. The reasons we have provided for this point are that general impulsivity and temporal impulsivity often come apart (van Baal, Walasek, et al., 2022), that temporal impulsivity is not stable across *time*, *modality*, and *context*, and that this problem is further exacerbated because intertemporal choice tasks are poor analogs for real-world choices.

## Dissociating Baseline Impulsivity From State and Environmental Influences

In their discussion, FFT posed several intriguing questions about whether (and, if so, why) individuals have different levels of *baseline* information or temporal impulsivity in light of the highly context-dependent adaptiveness of impulsivity: “Is there indeed a stable baseline?”, “If so, why is there a baseline?”, “Why do we not always adjust our impulsivity to match environmental demands?”, and “Is this baseline fixed after a sensitive period or malleable across the lifespan based on experience?” In this section, we will move beyond our discussion of why temporal impulsivity measurements from intertemporal choice tasks do not generalize well, and focus on the shortcomings of measures of trait general impulsivity (i.e., behavioral and self-report measures). We will first examine the features of baseline trait impulsivity, after which we will discuss why current self-report and behavioral measures of trait impulsivity are unable to measure this baseline.

By baseline impulsivity, we interpret FFT to mean a disposition towards both kinds of impulsivity across many diverse environments and in various states—a disposition that remains even when the situation does not prompt or reward this disposition. Considering that we have already discussed conceptual issues, we will now focus on the tension between state and environmental influences on behavioral and self-report trait measures. As such, we believe the criticisms mounted in the current section apply to trait measures of other constructs where the adaptiveness of the trait is also susceptible to environmental variables and the individual’s phenotypic state.

For the purpose of this discussion, we will first dissociate *baseline impulsivity* from regular *trait impulsivity*. Consider two individuals who are otherwise equal, but one has lived in a resource-scarce environment their entire life, while the other has transitioned from a resource-rich environment to a resource-scarce environment. Further, we assume that

resource-scarce environments make general impulsivity adaptive (see FFT for their discussion for more specific conditions of the adaptiveness of temporal and information impulsivity). Now consider that we have measured both individuals' general impulsivity twice over their lifetime. For the second individual only, their general impulsivity was measured in both resource-scarce and resource-rich environments. Imagine that we find that both individuals scored high in impulsivity in both instances. For both individuals, we will infer that they are high in *trait impulsivity*. Nonetheless, it is only for the second individual may we infer that they are high in *baseline impulsivity*: This individual tends to be impulsive, even if the situation does not call for it. For the first individual, in this simple example, we have no information about their baseline impulsivity because, other than their age, no other variables changed.

In the rest of this section, we argue that current methods are unable to capture baseline impulsivity. We believe that dissociating baseline impulsivity from what is prompted by state and environment is useful in clinical settings, as well as in policy settings. Proper attribution of behavior to disposition and situation will help clinicians decide on treatment and recommendations for their patient's social circle. Equally, for policymaking, teasing these apart will help us understand how people's behavior might deviate from expected patterns, with consequences for people's welfare. This difficulty in dissociating the influence of disposition and situation on behavior introduces the second issue we will discuss. Namely, that behavioral and self-report measures of trait impulsivity (be it general, informational, or temporal) are restrictive if their measurement and results are not dynamic. We explain this issue in more detail below.

In measuring a baseline trait when the context plays a substantive role, a large amount of trait variance is due to an individual's current phenotypic state and environment (Fleeson, 2004). Until the context changes, it is difficult to dissociate how much of the impulsivity we

measure is attributable to the individual's current state and environment, and how much to the individual's disposition. We would be able to measure important variables such as socioeconomic status, childhood factors and the like (see e.g., Acheson et al., 2011; Ishii et al., 2017; Reimers et al., 2009), but these are only instrumental variables of how individuals' environments and states are different and how they warrant, or do not warrant, impulsivity.

When impulsivity (the broad conception) is measured with self-report measures, the dynamic nature of impulsivity is partially controlled, as participants are prompted with questions that concern their inclinations in different scenarios. These measures also have two problems that limit their generalizability to future situations. First, the questions only deal with scenarios that participants have encountered, which limits the degrees of freedom for investigating counterfactual scenarios where relevant variables are changed. For instance, we do not know whether an impulsive subject who lives below the poverty line would be impulsive if they were wealthy; they may need to be temporally impulsive to signal social status (Walasek & Brown, 2015). Second, we relinquish most information gained by taking these dynamic measurements because they are reduced to a single number. That is, even if we know that an individual is impulsive in one scenario but not in others, the scoring will collapse this information into a single number. These two problems limit the generalizability of the impulsivity measure to future contexts, especially to scenarios that are dissimilar to the questions asked or anything the individual has not encountered before.

Thus, for both behavioral and self-report measures of trait impulsivity, researchers do not have complete access to the relevant environmental and state variables, or the individual's beliefs, and up until now, these measures have not been adapted to vary systematically the variables relevant for any type of impulsivity. The result is a trait measurement of impulsivity that is a mix of underlying baseline impulsivity and however the individual's state and environment prompt them to act. This entanglement in trait measurements causes a problem

for predicting future behavior. For example, if an individual lives in a poor neighborhood where resources are scarce and there is fierce competition, the results of FFT's analysis may suggest that it is adaptive for the individual to exhibit high levels of temporal impulsivity and information impulsivity. One might then also expect their trait impulsivity to change when they move to a less underserved neighborhood, but because we do not know how much of the variance in their impulsivity was explained by the environment and their state, we cannot predict the size of this reduction in trait impulsivity. Importantly, they might react adaptively to changes in their environment or not—our trait measures of impulsivity bring us no closer to the answer in this regard.

We believe that this lack of predictive power is a missed opportunity; researchers could be assessing whether people respond adaptively to new scenarios. We thus propose to extend FFT's findings on those scenarios that render different kinds of impulsivity adaptive—and thus when individuals are likely to be impulsive—by suggesting that we should adjust our trait measures accordingly.

To address the mismatch between the context-dependent nature of impulsivity and current trait measures, we believe that, first, we should assess the individual's background and environment for various markers of harshness and unpredictability, as identified by FFT. For example, in the context of job search, unpredictability may apply to delays (e.g., typical length of a job interview), spatial presence of rewards (e.g., availability of jobs in a given region), or stability of resources over time (e.g., do job adverts come and go or is there a consistent supply?). In doing so, the researcher ought to also keep in mind their phenotypic state ("Does this individual have phenotypic reserves such as money, a social network, and proper housing?"). This trait measure should then also provide rich information about the individual's impulsivity, instead of generating a single scale or subscale results. Second, behavioral measures should be dynamic, rather than static, varying parameters that make it

more or less adaptive to be impulsive. This dynamicity of impulsivity measures will help researchers and clinical psychologists gauge how people might react to new circumstances and whether those reactions are appropriate in light of their condition. Indeed, such rich measures of impulsivity will then complement each other. Self-reported trait measures will provide historic and current information about how the individual is interacting with the world, while behavioral measures will provide a sense of how they might behave if their circumstances were to change.

Our proposal here then is that in behavioral and self-report measures of different types of impulsivity, we are underfitting our models to the construct. The static nature of the current measures therefore misses meaningful variation. In our call for dynamicity here, we should then also caution against overfitting. It is important we strike a balance between clinically and economically useful information about impulsive tendencies in different scenarios and trying to describe too much about an individual's impulsivity, which reduces predictive accuracy.

## Recommendations for Future Research

FFT showed that the adaptiveness of temporal and information impulsivity, and thereby the likelihood that people will be temporally or informationally impulsive, is dependent on the individual's state and features of their environment. We have argued that it is important to use these insights to design better measurement tools for the different dimensions and varieties of impulsivity. Such improvements will enable us to build a better picture of individual differences and general tendencies of the population—one that tells us about behaviors that may or may not be adaptive depending on the context.

In our view, then, better behavioral measurement tools for impulsivity are those that, first, measure impulsivity in contexts where its local adaptivity is known. This way, we

measure whether individuals deviate from optimal choice and behavior patterns by being too "impulsive" or not "impulsive" enough. Second, tools need to allow for a certain degree of realism that enables us to structurally vary important parameters such as the unpredictability of future rewards, the individual's phenotypic state, the decision frequency, mutual exclusivity of options, and so forth. Indeed, we may also consider tools that can dynamically vary the type of environment based on the baseline impulsivity levels of the individual—assessing their adaptability. If the environment is constructed to be "neutral", we run the risk of creating more measurement tools that swap a meaningful context for an artificial one, without gaining any generality.

The kinds of dynamic tasks we believe would be useful are tasks tailored to capture, for instance, temporal and information impulsivity, where the manipulability of the situation is akin to the patch foraging task (Constantino & Daw, 2015). Such tasks allow us to observe participants' behavior in different states and environmental conditions, providing information on how participants adapt to their new situations in the short term. One could also consider a strategy method approach, such as is used in game theory (Fischbacher et al., 2012). The fact that these tasks will measure short-term adaptation will likely be one of the main limitations.

The insights these dynamic tasks garner will likely need to be complemented with longitudinal research (see e.g., Kometani & Ohtsubo, 2022), where samples are selected in ways that help us make inferences on long-term adaptations in information impulsivity and temporal impulsivity as a consequence of changes in state and environmental parameters. More generally, multi-disciplinary approaches to impulsivity research, in particular making use of evolutionary models from biology, evolutionary psychology, and economics, such as FFT have done, seems promising as an aid to make better behavioral predictions.

We should note that recently new initiatives have been produced that better fit these criteria for dynamic tasks. For example, the Cognitive Impulsivity Suite assesses different dimensions of impulsivity through gamified tasks (Verdejo-Garcia et al., 2021). There is also DOSPERT, which assesses people's risk preferences in different scenarios, and provides information about whether an individual is risk-seeking in one type of context versus another (Blais & Weber, 2006). Creating such a tool for temporal and information impulsivity would likely be useful for capturing individual differences in modality- and context-specific impulsivity.

To create dynamic tasks, the next step is to investigate how participants adjust their decision making, such as by comparing behavior with predictions from some of the formal models discussed by FFT. Insight may also be garnered through other frameworks such as the drift diffusion model (Dai & Busemeyer, 2014; Peters & D'Esposito, 2020), reinforcement learning (Mazur, 1987), and active inference (Pezzulo et al., 2018). For example, designing new paradigms where individuals must learn the underlying relationships between rewards and time could be used to study how the structure of the environment (e.g., uncertainty, baseline resource levels) influences both temporal and information impulsivity.

In retaining the realism of these tasks, researchers can vary the reward modality to identify which modalities' temporal and information impulsivity measurements might correlate with those of other modalities. Research in this domain is still in its infancy, but as a guide, we may take Trope and Liberman's (2010) Construal Level Theory or Walasek and Brown's (2021) concept of *covering values* (the higher order goals/standards against which objects are evaluated) as a starting point for generating hypotheses. Both of these approaches do not assume that everything can be compared on a single value scale (i.e., utility), but instead propose that many decisions and behaviors serve to attain overarching *construals* or *covering values*. We could then propose that if two modalities have more overlapping higher-

level or lower-level construals, or covering values, temporal impulsivity across these modalities may correlate more strongly. One may, for example, expect that temporal impulsivity for food might not be so different from those for beverages—if a decision-maker strongly prefers moderately rewarding food now over more rewarding food later, their preferences for beverages are likely more strongly correlated with this than, for example, those for money. Perhaps the same would go for temporal impulsivity in education and life-partner selection; these should be correlated more strongly than, say, those for drugs and holidays. As of yet, more research is to be done in the inter-modal intertemporal choice domain, which we take to be a special case of multi-attribute choice.

## Wider Implications of the Context-Dependence of Impulsivity

Trait measures of general impulsivity and intertemporal choice tasks tend to abstract away from precisely the interesting features of everyday manifestations of impulsivity: Its context-dependencies. FFT adopted the stance that not only is the adaptiveness of temporal impulsivity context-dependent but, therefore, also the likelihood that people will (and should) be impulsive in a certain situation. In doing so, FFT also aided the field in moving away from laying the responsibility for outcomes squarely on the individual (e.g., by proclaiming that they suffer from substance use disorder because they discount the future too much).

FFT showed that a multitude of contextual factors can reflect ecological rationality of temporal and information impulsivity, which helps us establish why certain behavioral tendencies may be more likely in one individual than another. A better understanding of the contextual factors that contribute to impulsivity is a tool we can use to avoid the fundamental attribution error (also referred to as correspondence bias; an over-readiness to attribute behavior to the character of the individual rather than the circumstances; Ross, 1977). Behaviors indicative of temporal or information impulsivity, rather than being due to an

innate characteristic of an individual, often depend on the structure of the environment and the phenotypic state of the individual. For example, when an individual's environment is resource-scarce because they lack the training to join the workforce, they may discount the future heavily, possibly leading to substance use problems. This insight, paired with rich information about the individual(s) in question, will further stimulate policymakers, clinicians and social workers to address the conditions instead of blaming the individual for any resulting negative outcomes. Keeping such insights in mind is vital for successful public policy because changing the environmental inputs and systems that shape preferences and behavior is far more effective than telling people to use their self-control or to be more patient (Chater & Loewenstein, 2022).

Addressing the misperception that all "impulsivity" is maladaptive is important because of the stigmatization of disorders associated with the construct, such as borderline personality disorder (Sheehan et al., 2016), gambling disorder (Delfabbro et al., 2021), and attention deficit hyperactivity disorder (Godfrey et al., 2021). Impulsivity is frequently a target for the stigmatization of these disorders because being impulsive is widely considered imprudent. In the case of attention deficit hyperactivity disorder, it is partly the associated impulsivity that leads people to deem those living with the disorder "dangerous". For gambling disorder, the impulsivity of affected individuals contributes to their perceived blameworthiness for their condition. This sentiment is echoed in the report commissioned by the Victorian Responsible Gambling Foundation, which states that "Many also assign blame for the problem to the individual affected, seeing them as impulsive, irresponsible, greedy, irrational, anti-social, untrustworthy, unproductive and foolish" (Hing, 2015). Stigmatization is not only bad for wellbeing, but also acts as a barrier to seeking treatment for mental disorders. We intend for this commentary to create more understanding that being

“impulsive” or choosing smaller-sooner rewards does not imply poor adaptation; such patterns often say more about the conditions in which an individual lives.

Taken together, FFT provided crucial insights for our understanding of temporal and information impulsivity, and for future research on the topic. The context dependence of the adaptiveness of impulsivity highlights that our behavioral measures require a better fit with the ecological conditions. We have argued that to assess people’s underlying disposition towards impulsivity, and the adaptiveness thereof, behavioral measures of impulsivity need to be dynamic and trait scale measures need to provide rich information about the person’s state, environment, and behavioral tendencies across contexts. Creating more dynamic measures of the various dimensions of impulsivity that acknowledge the state and environment of the individual will be useful for understanding the causes of human behavior. This improved understanding may help inoculate us against the fundamental attribution error and reduce the stigma associated with impulsivity.

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