Interactions and implications of Fuzzy-Trace Theory
for risk taking behaviors in Bipolar disorder

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Abstract

Background. According to Fuzzy-Trace Theory (FTT), qualitative, bottom-line, "gist" reasoning leads to less risk taking and more mature decision-making, less easily swayed by emotions than quantitative, detail-oriented, "verbatim" reasoning. In Bipolar disorder deleterious risky behaviors are common. Prior research confirmed the relationships posited between FTT and risk taking. We aim to understand whether FTT acts upon risk taking in the manner proposed in the FTT framework, namely, that (a) gist "values" mediate the role of "categorical gist". Furthermore, the roles of mania and impulsivity, cited as factors for risk-taking, remain to be clarified. In this study, we investigate if (b) manic symptoms and impulsivity moderate these relationships.

Methods. Participants (N = 105) completed an online survey including demographics, clinical variables, symptomatology, FTT, risk taking and risk perception.

Results. Mediational models indicated that (a) Gist Values mediated Categorical Gist's effect on risk taking, as expected by the FTT framework. (b) Impulsivity moderates risk taking, but manic-type symptomatology does not.

Limitations. Voluntary, self-report surveys may have low participant motivation and limit the diagnostic validity and the in-patient generalizability of the results.

Conclusions. The results move beyond a focus on mood-related aspects of Bipolar disorder and confirm the importance of understanding reasoning processes like FTT in combination with impulsivity, as potential behavioral factors of risk taking in Bipolar disorder. The clarifications on FTT's functioning as a mechanism prescribe possible openings for more efficacious reduction of risky behaviors through behavioral interventions focusing on value creation.

Keywords: Bipolar disorder; Fuzzy-Trace Theory; Decision-making; Risk Taking; Gist; Verbatim

Introduction

Risk Taking and its Consequences in Bipolar disorder[5]

Risk taking (RT) is ultimately an intentional decision, driven by subjective perceptions of the environment, to engage with uncertainty (Slovic, 2010). Therefore, investigating decision-making could inform research on RT.

Bipolar Disorder (BD) manifests difficulties in decision-making and increased risk engagement compared to normative samples (American Psychiatric Association, 2013) . Examples of risk engagement in this group include substance/alcohol use and abuse, violent crime, increased sexual promiscuity, and unwise financial activities (Fazel et al., 2010; Holmes et al., 2009; Kopeykina et al., 2016; McIntyre et al., 2007; Wilens et al., 2004). A recent qualitative study in the area showed the nuanced perspective individuals with BD; from their perspective, risk and the decisions leading up to it impact their overall well-being, and there is a clear satisfaction when they are better able to manage risk (Wah et al., 2020).

These behaviors are associated with an even larger increase in risk taking, worsened outcomes overall, and increased length or frequency of mood episodes (Dalton et al., 2003; Hirschfeld et al., 2002; Holmes et al., 2009; Solomon et al., 2010). Risky sexual behaviors increase probability of sexually transmitted infections (STIs), and are related to drug use (Heaphy et al., 2010; Meade et al., 2008). Risk of death is two times higher, and risk of suicide is 10-30 times greater in BD than in the general population (Hirschfeld et al., 2002; Schaffer et al., 2015).

Causes of Risk-Taking in Bipolar disorder

RT is more marked during manic episodes (American Psychiatric Association, 2013). Research into drivers of RT and faulty decision-making in BD implicate emotions, trait impulsivity, cognitive deficits, and neurobiological mechanisms related to reward.

Emotional arousal, an aspect of BD, interacts with impulsivity to contribute to emotion-based impulsivity, which has been found to lead to more risk-taking in healthy individuals (Derefinko et al., 2014). Impulsivity is correlated with RT in clinical and normative populations, but individuals with BD score high even comparatively in both of these characteristics (Christodoulou et al., 2006; Dougherty et al., 2004; Reddy et al., 2014; Swann et al., 2009, 2009). Cognitive deficit factors include response inhibition, less discounting of delayed rewards over development, and hypersensitivity of the behavioral activation system, which may increase reward sensitivity (Swann et al., 2003; Urošević et al., 2016). Neurobiological reward related brain activation and dopamine sensitivity point to reward processing abnormalities (Whitton et al., 2015), which may explain preference for high reward and risk activities. This may be particularly enhanced in manic periods during learning (Burdick et al., 2014).

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5   Abbreviations: BD – Bipolar Disorder; FTT – Fuzzy-Trace Theory; RT - Risk Taking; BART – Balloon Analogue Risk Task; MDQ - Mood Disorders Questionnaire; 7up7down – 7 up 7 down Questionnaire; GC - Gist Categorical Risk; GP - Gist Principles; GR - Global Risk; VSR - Verbatim Specific; VQ - Verbatim Quantiative Risk; BIS-15 – Barratt Impulsivenes Scale; BIS - Behavioral Inhibition Scale; BAS - Behavioral Approach Scale; DOSPERT - Domain-Specific Risk-Taking and Risk-Perception Scale

These findings inform RT mechanisms biologically and developmentally. Nonetheless, an individual's judgment and decision-making processes are also integral to RT. Current treatments for BD, which attempt to make changes through mood stabilization, psychoeducation, and recovery, could benefit from investigations into the decision-making mechanisms behind RT (Hirschfeld et al., 2002).

Fuzzy-Trace Theory, a Decision-Making Theory

Fuzzy-Trace Theory (FTT), a dual-processing, decision-making, memory theory incorporates the subjectivity of perception of risk and the intentionality of taking risks (Reyna and Brainerd, 1994). FTT claims that decision-making (including RT) is determined by how information is encoded into, and later retrieved from, our memories (Reyna and Rivers, 2008). Risk perception, therefore, may be understood as an analog to the reasoning processes behind RT.

According to FTT, two representations of memories, simultaneously encoded and selectively retrieved, serve as a "dual-process". Verbatim are shallow and detailed representations of facts, quantitative information, graphs, numbers, pictures, and any other form of information (Reyna, 2005, 2004). They fade quickly and are prone to inaccuracies due to arousal or emotions (Reyna and Brainerd, 1998).

Gist, also known as "fuzzy-traces", are durable, deep, bottom line representations of memories (Reyna, 2005, 2004). Their recall is more context-driven and susceptible to framing (Reyna and Brainerd, 1994). An example of a verbatim memory may be the "15% chance over a lifetime of developing an STI". The gist version of this memory is the interpretation of this chance as low, medium or high. The use of gist reasoning theoretically increases with age and may have links with crystallized intelligence (Spreng and Turner, 2019).

Applications of Fuzzy-Trace Theory in Bipolar disorder

In a preliminary study, it was observed that in individuals with self-report BD diagnoses, higher gist reasoning was associated with lower RT, while higher verbatim reasoning was related to higher RT (Sicilia et al., 2019).

Reduction of RT is currently auxiliary to treatments in BD and the targeted mechanisms of RT are often biological rather than behavioral. However, a behavioral approach to costly and consequential RT behaviors of BD (described above) could be of benefit. FTT, through integrating decision-making and memory theories, may be well positioned to reduce risk through cognitive-behavioral interventions. Promisingly, one RCT applying FTT principles has shown efficacy in reducing sexual RT in adolescents, and FTT has informed interventions in psychosis as well as the study of decision-making and memory in both Autism and Alzheimer's (Landa et al., 2016; Reyna and Brainerd, 2011; Reyna and Mills, 2014, 2007).

Nevertheless, in order to advance our understanding of FTT as a model of RT in BD, the roles of certain mechanisms ought to be specified. Notably, the RCT mentioned above emphasized extracting gist and retrieving core values in risky situations (Reyna and Mills, 2014). This reflects the model proposed in Rivers et al., (2008), where "categorical" gist, reflecting specific themes, works through its connection with gist "values", reflecting core values. However, the mechanism

through which gist values explain categorical gist, to our knowledge, remains untested.

Furthermore, gist and verbatim encoding and recall is highly dependent on emotional experiences (Rivers et al., 2008). Gist creation is impacted by valence (whether an experience is viewed positively or negatively). Mood (one's current state of mind) drives retrieval, and verbatim may thus be implicated (Rivers et al., 2008).

Therefore, manic episodes may alter RT, gist, and verbatim (Mills et al., 2008). Manic states may also increase RT through enhanced reward processing, or through increasing positive emotions and approach behaviors (actions that maintain and enhance current positive emotions), which may manifest as RT and keep individuals with BD on a "high" (Alloy and Abramson, 2010; Gruber, 2011; Whitton et al., 2015). If FTT processing is associated with RT, and easily influenced by arousal or emotions, then mood state, particularly severity of mania, may moderate part of these relationships. If mania does indeed alter how FTT functions in RT, then this has implications for further use of this theory in research and in treatment.

The same reasoning about influences to the association of FTT processing with RT can be extended to impulsivity. As detailed before, impulsivity has a particularly important role in BD, even compared to other clinical populations (Christodoulou et al., 2006; Dougherty et al., 2004; Reddy et al., 2014; Swann et al., 2009, 2009). However, these deficits in impulsivity do not necessarily impel inadequate performance on behavior tasks that assess planning and risk (Holmes et al., 2009; Lombardo et al., 2012). Our understanding of the potentially differential effect of impulsivity as a factor contributing to RT in BD may also be elucidated by the application of the FTT model.

Aims of the Present Study

Given this information, this paper aims to: (a) test whether the effect of categorical gist on risk is mediated by gist values, in accordance with the models in Rivers et al., (2008), and (b)evaluate if manic-type symptomatology or impulsivity moderates the relationship between FTT and risk endorsement. We anticipate that (a) gist values will mediate categorical gist's effect on risk, and (b) varying levels in manic or impulsive symptomatology will explain FTT's role in levels of reported RT.

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Method

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Participants

One hundred and sixty one English-speaking adults completed at least the demographic portion of our voluntary anonymous online questionnaire. After screening for incomplete responses and compliance, 107 participants (age > 18) who reported bipolar spectrum disorder diagnoses were retained. There were two periods of recruitment (September 2016 to March 2017, April 2017 to June 2017). There were no exclusion criteria for gender, sexual orientation, or current mood states.

Procedure and Materials

Participants completed six self-report measures: the Mood Disorder Questionnaire (MDQ; (Twiss et al., 2008)), the 7 up 7 down Inventory (7up7down; (Youngstrom et al., 2013)), the Fuzzy Trace measures (Mills et al., 2008; Reyna,

2008), the 15-item Barratt Impulsiveness Scale (BIS-15; (Spinella, 2007)), the Behavioral Approach or Inhibition Scale (BAS/BIS; (Carver and White, 1994)), and the Domain-Specific Risk-Taking and Risk-Perception Scale (DOSPERT; (Blais and Weber, 2006)), and one RT task (second recruitment period only), the Balloon Analogue Risk Task (BART; (Lejuez et al., 2002). Only measures used in the subsequent publication are further detailed.

Demographics and Clinical Profile

The demographics portion included questions about location, age, gender, employment, ethnic background, marital status, education, and English language level. The clinical profile included questions about current medication, number of past episodes and duration, co-morbid diagnoses, age at diagnosis, diagnosis type, current mood state, other medical diagnosis (including STIs), and current or past treatments.

Current Symptomatology

Mood symptom level was assessed using the 7up7down (Youngstrom et al., 2013), of which the 7up subscale was used in this study to measure manic-type symptomatology. The 7up7down inventory is a 14-item questionnaire with high internal reliability (.83 for mania/7up; .95 for depression/7down; sample Cronbach's α = .92/7up, .96/7down) based on the General Behavior Inventory and measures BD symptom severity or phase (Youngstrom et al., 2013). Higher scores indicate higher respective symptomatology.

Fuzzy-Trace Theory

Decision-making as understood in existing FTT literature was assessed using the gist and verbatim scales, which place participants on gist/verbatim continuums while addressing a specific topic (Mills et al., 2008; Reyna, 2008). Mirroring the descriptions of these constructs, gist measures and responses are broadly worded as compared to verbatim measures. The scales are expected to trigger different mental representations of risk by addressing the specific topic of sexual risk, without pinpointing any particular STIs other than HIV/AIDS. Despite this, the focus of these questionnaires is the broad mental representation and not the specific topic. For more information on these scales, please see (Reyna and Mills, 2014) or contact the corresponding authors.

The gist scales consist of the Gist Categorical Risk (GC) subscale (sample Cronbach's α = .79), the Gist Principles (GP) subscale (sample Cronbach's α = .81), which allows us to inspect Gist Values, and the Global Risk (GR) subscale (single-item measure). The verbatim scales consist of the Verbatim Specific Risk (VSR) subscale (sample Cronbach's α = .79) and a Verbatim Quantitative Risk (VQ) subscale (single-item measure). Higher scores imply higher endorsement of the respective reasoning (Reyna and Mills, 2014).

Impulsivity

Impulsivity was assessed using BIS-15. This shortened version of the 30-item BIS-11 retains good psychometric properties and asks individuals to agree or disagree with statements on three subscales: attentional, motor, and non-planning (Patton et al., 1995; Spinella, 2007). Higher scores indicate higher trait impulsiveness. One item was mistakenly -omitted from the BIS-15 ("I squirm at

plays or lectures"). The scale showed good reliability for this sample even without this item (sample Cronbach's α = .9).

Risk Perceptions and Behaviors

RT behaviors were assessed with the 60-item DOSPERT (Blais and Weber, 2006). The questionnaire has moderate internal reliability and measures participant perceptions of risk and risk taking behaviors (risk perception)(sample Cronbach's α = .93), as well as the participant's likelihood of participating in them (RT)(sample Cronbach's α = .9). These two scales are generally negatively correlated with one another. The questionnaire includes five subscales: ethical, recreational, health, financial, and social (sample Cronbach's α range = .76 - .88, excepting ethical (RT), where α = .64).

Procedure

Ethical Approval and Concerns

This project was approved by the Faculty of Health and Medicine Research Ethics Committee (FHMREC) at Lancaster University, in the United Kingdom.

Recruitment

Recruitment occurred online through research organizations, advertisements on social media, forums, charities, support groups and advocacy groups, including in the United Kingdom, the United States, Canada, Australia, and New Zealand.

Procedure

All components of this quantitative, correlational study were completed online. Data was collected through REDcap (Harris et al., 2009), and hosted by Lancaster University.

The first pages of the survey explained the study and directions to participants, informed them of their rights (including confidentiality and anonymity), specified the absence of remuneration, and verified informed consent.

Participants completed the survey in the following order: demographics, medical history, MDQ, 7u7d, FTT scales, BIS-15, DOSPERT, BIS/BAS, BART (if applicable). All participants received the contact information of the research team and distress resources, and those who completed could leave feedback on their experience.

Statistical Analyses

All analyses were completed using R (version 3.6.1). We first identified participants who had only sufficiently completed the demographics portion of the study (non-completers) and those who had also less than 20% missing data on each pertinent questionnaire (completers).

The completers dataset was then used to investigate confounds of FTT measures identified through literature review, test for internal correlations between FTT and DOSPERT subscales, and identify outliers. Once outliers were removed, we compared demographic characteristics of completers and non-completers, using independent t-tests and Chi-square tests, assessed final sample demographic characteristics, and assured questionnaire reliability. We generated five multiply imputed datasets with the MICE package (using predictive mean matching) on this

final dataset for use in inferential models (van Buuren and Groothuis-oudshoorn, 2011).

To address aim (a), (Do gist values (GP) mediate the relationship between categorical gist, verbatim and risk?), we used path analyses in the Lavaan package (Rosseel, 2012). For aim (b), (Do mania and impulsivity moderate the relationship between FTT and RT?), a series of multiple regressions were tested using Lavaan.

Based on literature and preliminary correlations, the VSR and GP subscales of the FTT scales were used for the analyses concerning aim (b). Given its role in RT, according to the literature, age was kept as a control throughout all tests. Assumptions and multivariate outliers were evaluated before conducting final analyses. Independent variables were mean-centered prior to the creation of interaction terms.

Results

Sample Characteristics

A total of 263 individuals initiated the questionnaire. Of these, 163 participants completed at least the demographics portion. One-hundred and seven participants of 163 were retained with complete data (<20% missing data per questionnaire, $n = 107$, non-completers, $n = 56$). Two influential cases ($n = 2$) in the GG and the VSR subscale were identified during analyses of internal correlations between FTT subscales, and were removed. Therefore, a total of 105 participants [*M(SD) age* =45.95(14.23), 64% female, 91% white] were retained for multiple imputation and final inferential tests. No participants reported experiencing distress as a result of the study. Analyses of differences between completers and non-completers showed that completers ($n = 105$) were significantly older, $t(82.18) = -3.79$, $p < .01$ than non-completers ($n = 56$).

The demographic characteristics of final sample (Table 1) indicate that 38% were attending psychotherapy of some sort and 88% were receiving medication for mental health diagnoses. Self-reported diagnoses were split between Bipolar I (35%), Bipolar II (40%) and "Other" (Bipolar N.O.S. and schizoaffective disorder) (25%). Eighty-four percent of the sample screened positive for BD based on the MDQ. Forty-six percent of participants self-reported that they were currently experiencing a mood episode.

Gist Principles as a Mediator of Categorical Gist

Hypothesis (a) tested the model implied in Rivers et al., 2008 that GC mediates the relationship between GP and risk.

As depicted in Figure 1, after specifying a just-identified model (with no left-out paths) we observed a significant indirect effect, where GC reduce RT indirectly through the mediator, GP ($b = 0.44$, $se = 0.18$, $t = 2.46$, $p = .01$). Comparatively, VSR only had a significant direct effect on RT ($b = 4.18$, se = 1.22).

Manic-type Symptomatology or Impulsivity as Moderators of Fuzzy-Trace Theory & Risk Endorsement

Our final hypothesis tested whether manic-type symptomatology (7-up) or impulsivity (BIS-15), moderated the relationships between select FTT scales (GP & VSR) and the DOSPERT-RT.

The models explained significant amounts of variance, (R^2) of .43 – .47, but none of the individual interaction terms involving mania (7up*FTT) were significant

(Table 2). This means that manic-type symptomatology did not significantly moderate the relationship between FTT measures and DOSPERT-RT.

The BIS-15 was a significant moderator of the relationship between FTT (GP & VSR) and DOSPERT-RT. As can be seen in Figures 2 and 3, the combination of low gist and high impulsivity was associated with higher levels or RT. As scores on GP increased, the positive relationship observed between impulsivity scores and RT decreased. For those with low levels of impulsivity (below +1SD), the relationship between GP and RT was not significant (*simple slope* = 1.01, *se* = 1.36).

A similar, but inverse, pattern was observed between VSR and impulsivity. High levels of verbatim and impulsivity were associated with higher RT. However, for those with low levels of impulsivity, the relationship between verbatim and RT was not significant (*simple slope* = -0.79, *se* = 2.03).

Notably, GP and VSR main effects with RT remained significant with the addition of mania, impulsivity, age and interactions into the models (b = -1.92, *se* = 0.88 and b = 3.39, *se* = 1.03, respectively). Nevertheless, impulsivity was always the predictor with the biggest effect. A one standard deviation increase in impulsivity was associated with a 0.43 standard deviation increase in RT, compared with a decrease of 0.17 standard deviations in RT associated with GP. In the second model, these effects were associated with a 0.47 standard deviation increase in impulsivity, and an increase of 0.24 standard deviations in RT was related with VSR. Comparatively, the size of the effect related with one standard deviation increase in age was ~0.18 standard deviations in RT.

Discussion

Our recently published work, Sicilia et al., (2019), investigated whether FTT was a suitable way of understanding RT in BD. This work elaborates on those past results, addressing *how* the varying components of the FTT model, namely verbatim and gist processing, interact and work together with factors commonly implicated in RT and present in BD.

We investigated whether (a) gist values (GP) mediated in the relationship of categorical gist (GC) with risk taking, as proposed by models of FTT and whether (b) manic-type symptomatology (7up) or impulsivity (BIS-15) moderated the relationship between FTT variables (GP and VSR) with RT.

Gist Principles as a Mediator of Categorical Gist

Our results supported our first hypothesis, confirming the mediating role of gist values (GP) between categorical gist (GC) and risk. In other words, increased scores on GC indirectly contributed to the reduction in risk endorsement through GP.

This finding supports the hierarchical model of gist proposed by Rivers et al., (2008). In this model, a choice (i.e. to try smoking or not), is first treated through concrete (factual) knowledge and valenced (emotionally charged) knowledge about the two options. This information about the decision is then encoded as both categorical and situation-specific gist and verbatim. The retrieval of "appropriate gist values/principles" then leads to a "proper" implementation of gist and finally, the resulting behavior. This demonstrates an implied principle in FTT, that the impact of categorical and situation-specific gist on behavioral outcomes (such as RT) is mediated by gist values.

In the example of sexual risk and the scales in the study, items in the GP subscale represent underlying value-based beliefs about a given risk situation (i.e. "I have a responsibility to my partner to not put him/her at risk."), while items in the GC subscale represent the gist of how individuals think about the tendency of risk in the given situation (i.e. "It only takes ONCE to get pregnant or get an STD"). Although both are gist related to a specific situation, the GP subscale items emphasize core values (i.e. protecting loved ones) while the GC subscale items emphasize gist related to risk (i.e. relative understanding of riskiness). Our results demonstrate that gist beliefs tied to risk become relevant in choices when core values tied to a situation are at play.

This theoretically underpins interventions targeting risk reduction, and posits that rudimentary understandings of relative risk are insufficient to buffer against RT. Beliefs and personal semantic values are linked in their contribution to behavior change (Grube et al., 1994). Encouraging the construction and retrieval of these core values would increase saliency of categorical gist for that given situation, as well as maintain pertinence for varying situations of categorical gist retrieval. For example, addressing the core values a person holds (i.e. respect or care for their sexual partner), when discussing the risk of certain sexual behaviors is more generalizable than asking them to simply consider the risk of contracting an STD. Interventions informed by FTT, focused on lowering risk-taking facilitating gist reasoning follow this schema. Reyna & Mills, 2014, tested a sexual risk reduction treatment in adolescents. They focused on encouraging the formation of gist memories and core values, and facilitating the recall of those gist memories based on already existing RT interventions, a process reflected in our theoretical findings. This model may be suitable for tackling RT behaviors in BD.

Manic-type Symptomatology or Impulsivity as Moderators of Fuzzy-Trace Theory & Risk Endorsement

Broadly speaking, gist values (GP) predicted lower RT behaviors, while verbatim measures (VSR) predicted higher RT in this sample. Both effects represented small effect sizes, but were statistically significant even when controlling for confounding variables, such as age, mania, and impulsivity. This reflects the unique contribution of these cognitive processes to RT, and replicate past findings reported by Sicilia et al., (2019)

As discussed earlier, mania is an often-cited culprit for risky behaviors in BD (Thomas et al., 2007) and FTT is also reportedly impacted by mood (Reyna and Rivers, 2008). Nevertheless, our results showed no significant main effect of mania and show no moderational effect of manic-type symptoms in the relationship between FTT variables and RT. This may be because of overlapping variance with other constructs in the model (such as impulsivity). The lack of significance in these findings, and particularly the interaction term, highlights the independent role of FTT beyond manic-type symptomatology as an unaddressed potential variance-explaining cause of risky behaviors in BD.

Our findings do, however, indicate both a main and a moderational effect of impulsivity in the relationship between FTT variables and RT. At average or high levels of impulsivity, gist values weakened the relationship between impulsivity and RT. For those with lower levels of impulsivity, gist values did not play a significant

role in RT. A similar pattern was found for verbatim, where for those with average or higher levels of impulsivity, higher levels of verbatim were associated with a strong relationship between impulsivity and RT. For individuals with lower levels of impulsivity, the verbatim-risk relationship was no longer significant.

Individuals with BD diagnoses and higher levels of impulsivity perform worse on risk taking tasks (Reddy et al., 2014), while individuals with high impulsivity have trouble adjusting to learning conditions in risk (Upton et al., 2011). The interaction described above suggests that increasing gist values and reasoning may serve as a possible avenue for risk reduction in individuals with high impulsivity.

In summary, the results of this study reiterate the importance of addressing decision-making processes as risk factors in their own right. The findings also demonstrates how the FTT decision-making process can be utilized to reduce risk engagement in a population diagnosed with BD, through increasing gist reasoning for those with high levels of impulsivity.

Implications

This work furthers our understanding of RT in mood disorder research, and may lead to new treatment options for individuals seeking care. FTT is now shown to be relevant for a range of conditions, including BD (Landa et al., 2016; Reyna and Brainerd, 2011; Reyna and Mills, 2007; Sicilia et al., 2019). Researchers in behavior disorders, substance use disorders, ADHD, and a variety of mental health problems already investigate decision-making difficulties and RT through cognitive processes (Ernst et al., 2003; Garon et al., 2006). Our results may spur further investigation into general differences in decision-making, or risk from a decision-based perspective in these fields as well as in BD.

Front-line treatments for BD focus on stabilizing mood and improving global functioning to improve well-being, avoid relapse, and reduce symptoms, including those derived from RT (Hirschfeld et al., 2002). However, since this study indicated that FTT plays a role in risky behaviors beyond mood additional treatments targeting RT in particular may be beneficial. Existing treatments drawn from literature could be used as a starting point (Reyna and Mills, 2014), linked with some of the findings described above. For example, since high levels of gist weaken the link between impulsivity and risk-taking, gist (and, as demonstrated by the first hypothesis, gist values in particular) may serve as a buffer to risky impulsive behaviors with detrimental consequences, notably common in BD (Swann et al., 2009, 2009).

Altering decision-making could be incorporated as an adjunct intervention, given its practical and somewhat easily applicable nature. Gist doubles as a simultaneously encoded perception of a verbatim memory. At retrieval, a number of factors, many subjective, determine the use of gist or verbatim (Reyna and Brainerd, 1994). This renders the process mutable at two moments, encoding and retrieval. Gist memories last longer, and are more adaptive forms of reasoning, changes have the potential to have sustained, as well as brief efficacy (Reyna, 2004).

FTT encourages a more dynamic, process and memory-based approach to risk, as a critical decision-making process of recognizing and evaluating the probability and magnitude of any given consequence (Reyna, 2004). Instead of

viewing risk as a negative outcome out of our control, risk also entails the process, under our control, that may lead to a negative consequence. Tackling problems with RT through the autonomous process of decision making may increase feelings of self-efficacy and control in individuals, which may have a positive impact on their well-being (Wah et al., 2020).

The costs of BD for society and the individual may also be alleviated through addressing decision-making comprehensively (Alonso et al., 2011; Baldessarini and Tondo, 2003; Hirschfeld and Vornik, 2005; Martinez-Arán et al., 2004). For example, medical complications may be reduced, lowering the healthcare burden of BD. Individuals may have less disruptive events in their lives, resulting in reduced frequency of manic episodes and increased and consistent participation in the economy throughout the year and throughout life (Malkoff-Schwartz et al., 1998). Finally, suicide is also a decision, albeit a very tragic and complicated one. Improving decision-making has the potential to reduce suicides in BD, saving lives and allowing individuals to continue to contribute to society in a meaningful way.

Limitations

Despite these promising results, caution in interpretation is always warranted. Individuals who fill out online surveys without compensation are not reflective of everyone, due to the technological literacy, the willingness, and the flexibility in time required. The level of education (60% with an undergraduate degree or higher) may be somewhat high for this population (Table 1). For comparison, one BD case registry showed that 30% of their sample completed college (Kupfer et al., 2002). Conscientiousness and agreeableness are purported factors in willingness to participate in surveys and may be over-represented in the sample (Rogelberg et al., 2003).

Methodologically, as the study is entirely self-report, including risk endorsement and clinical characteristics such as diagnoses, symptom severity, and current episodes, the internal validity of the study could be improved. However, certain elements of the study exemplify methodologically soundness: all participants received the same information and answered psychometrically validated questionnaires in a well-controlled online setting.

Finally, FTT scales, interrogating a specific topic, could lose pertinence when applied to broader subjects. It would be difficult if not impossible to address risky behaviors more broadly through FTT as the theory is content-specific (Reyna and Brainerd, 1994). In the meantime, sexual risk is clearly an appropriate topic for BD (American Psychiatric Association, 2013; Fazel et al., 2010; Holmes et al., 2009; Kopeykina et al., 2016; McIntyre et al., 2007)

Future Directions

Future studies should work to reach vulnerable populations and non-responders. The doubts typically associated with self-report studies could be mitigated by replicating the results using objective measures (e.g. behavioral tasks), and confirming diagnostic information using semi-structured interviews. However, the flexibility of the self-report format increases the external validity of scientific research, rendering it more easily conducted and potentially more broadly applicable.

Developmental studies show that gist increases with age and verbatim decreases with age (Reyna and Brainerd, 2011). In our sample (M = 45 y.o.), we could reasonably expect more gist reasoning than verbatim, and more reliability in these measures. Populations may find scales reflect their thinking patterns differentially, and future research should take this into consideration.

Future research could also test the moderating role of depressive symptomatology, or apply the FTT measures to broader risky behaviors in a more systematic way. Inclusion of control groups or other clinical groups (i.e. unipolar depression), would contextualize the results and strengthen the relevance of FTT for clinical populations.

Finally, studies investigating the feasibility and efficacy of cognitive-behavioral treatments in BD targeting impulsive decision-making processes through the encoding and retrieval of gist values would prove an invaluable practical contribution to the field.

Concluding Remarks

RT is the root of many serious negative outcomes for individuals with Bipolar Disorder and their loved ones, including prolonged episodes, worsened outcomes, and suicide (Hirschfeld et al., 2002; Holmes et al., 2009; Solomon et al., 2010). This research demonstrates that faulty behavioral and decision-making processes may play as important a role in risky behaviors as clinical or neurological factors.

Fortunately, if decision-making is a cause for risky behavior, it can also become a solution. Tackling risky behaviors or beliefs by encouraging a nuanced understanding of one's own values, thought processes, reasoning, and biases regarding risk seems a logical addition to current treatments. Risk, since it is inherent in all decision-making, should be conceptualized as neither entirely negative nor avoidable. Coupled with sensible decision-making skills and proper subjective perceptions (or gist values and representations) of consequences, as described in FTT, this mechanism of RT behavior may become an asset.

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Tables & Figures

Table 1

Demographics and Clinical Characteristics (n = 105)

Variable	
Age, n, Mean(SD), [Range]	105, 45.95 (14.23), [18-78]
Female, n (%)	67 (63.8)
In employment/Students, n (%)	48 (45.7)
Native English Speakers, n (%)	104 (90.5)
Undergraduate degree or higher, n (%)	63 (60)
In a relationship, n (%)	59 (56.2)
Ethnicity, n (%)	
White	96 (91.4)
Asian	3 (2.9)
Black	1 (1)
Mixed	2 (1.9)
Other	3 (2.9)
Time since diagnosis, n (%)	
In the past year	11 (10.5)
In the past 2-5 years	23 (21.9)
In the past 6-10 years	28 (26.7)
In the past 11-15 years	19 (18.1)
More than 16 years ago	24 (22.9)
Diagnosis Type, n (%)	
Bipolar Type I	37 (35.2)
Bipolar Type II	42 (40)
Bipolar NOS	21 (20)
Schizoaffective Disorder	1(1)
Other	4 (3.8)
Number of BD episodes experienced, n (%)	
Between 0-5 episodes	28 (26.7)
Between 6-10 episodes	28 (26.7)
Between 11-20 episodes	13 (12.4)
More than 20 episodes	36 (34.3)
Currently in psychological therapy, yes, n (%)	40 (38.1)
Currently receiving BD medication yes, n (%)	92 (87.6)

|	
Currently experiencing a mood episode yes, n (%)	48 (45.7)
Last mood episode more than 6 months ago, n (%)	19 (16.2)
Other co-morbid diagnoses yes, n (%)	36 (34.3)
Positive MDQ screen	88 (83.8)

Table 2

Manic-type Symptomatology or Impulsivity as Moderators of Fuzzy-Trace Theory Variables and Risk-Taking (n = 105)

Predictors	b	se [95% C.I]	p
Model 1 (Gist Principles)			
Intercept (Dospert RT)	56.77	2.2 [52.62 – 60.92]	.00
Age	-0.38	0.16 [-0.68 - -0.07]	.02
Gist Principles	-1.92	0.88 [-3.65 - -0.20]	.03
7 up	0.63	0.4 [-0.15 – 1.41]	.11
BIS – 15	1.34	0.25 [0.85 – 1.82]	.00
Gist Principles*Age	0.05	0.06 [-0.07 – 0.16]	.42
Gist Principles*7up	0.09	0.19 [-0.27 – 0.45]	.63
Gist Principles*BIS-15	-0.33	0.1 [-0.53 - -0.13]	.00
R2/R2 adjusted	0.43		
Model 2 (Verbatim Specific)			
Intercept (Dospert RT)	57.83	2.02 [52.62 – 60.92]	.00
Age	-0.33	0.15 [-0.68 - -0.07]	.03
Verbatim Specific	3.39	1.03 [-3.65 - -0.20]	.00
7 up	0.74	0.43 [-0.15 – 1.41]	.09
BIS – 15	1.46	0.25 [0.85 – 1.82]	.00
Verbatim Specific*Age	0	0.07 [-0.07 – 0.16]	.97
Verbatim Specific*7up	-0.08	0.31 [-0.27 – 0.45]	.80
Verbatim Specific*BIS-15	0.46	0.17 [-0.53 - -0.13]	.01
R2/R2 adjusted	0.47		

Figure 1
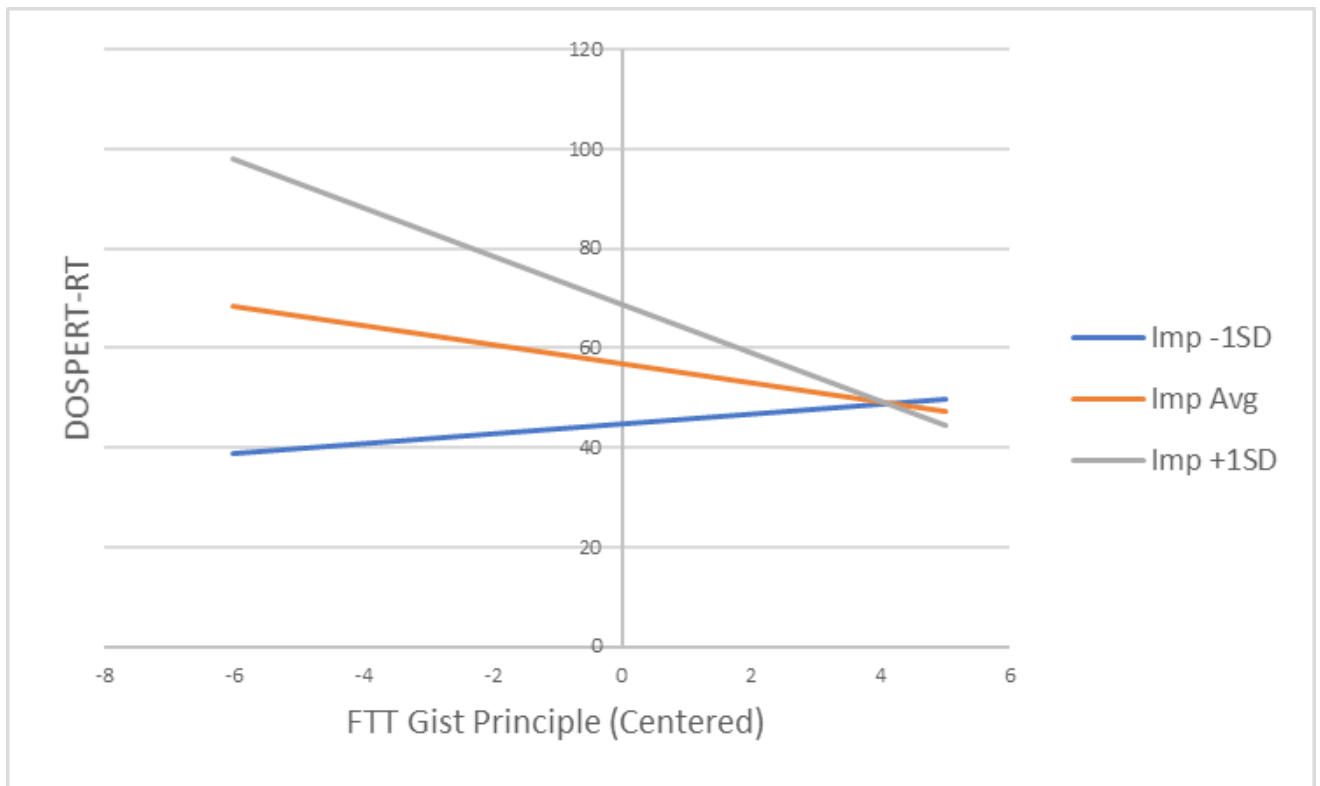
Gist Principles as a Mediator of Categorical Gist
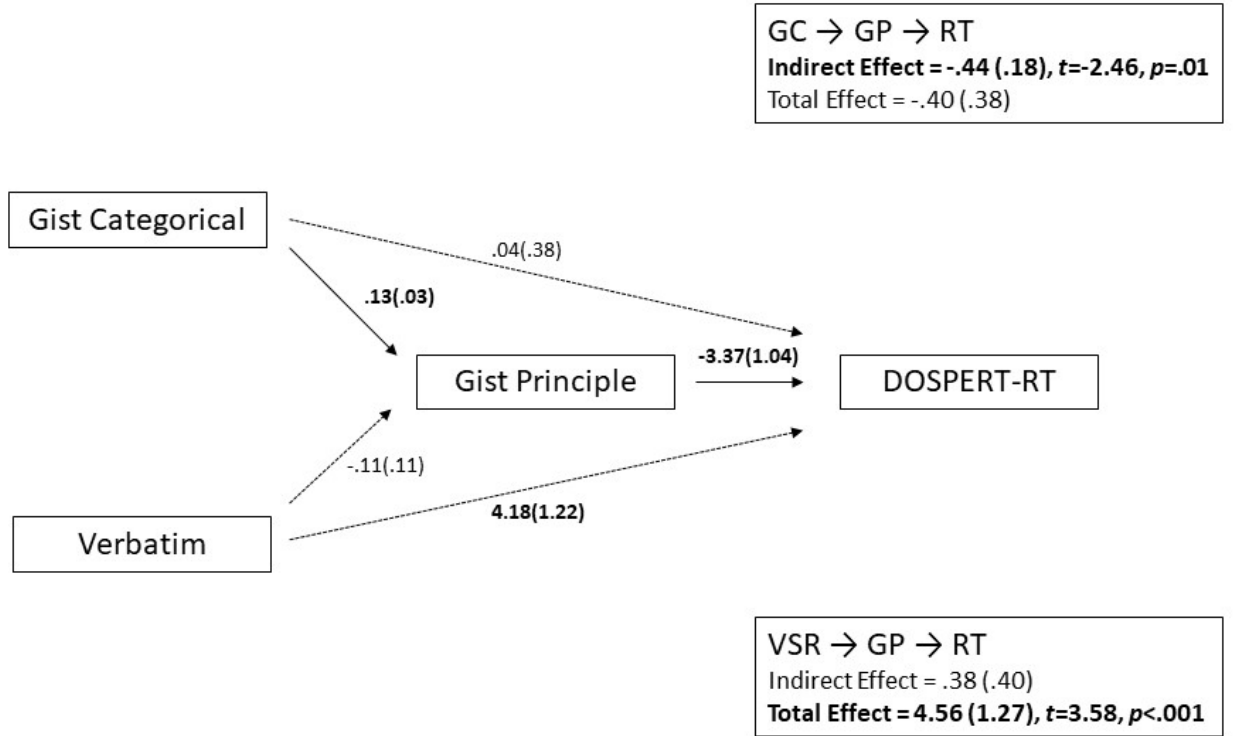
Note. Values in bold indicate statistically significant paths and effects ($p<.05$). GC = Gist Categorical, GP = Gist Principle, RT = Risk Taking, and VSR = Verbatim Scale.

Figure 2

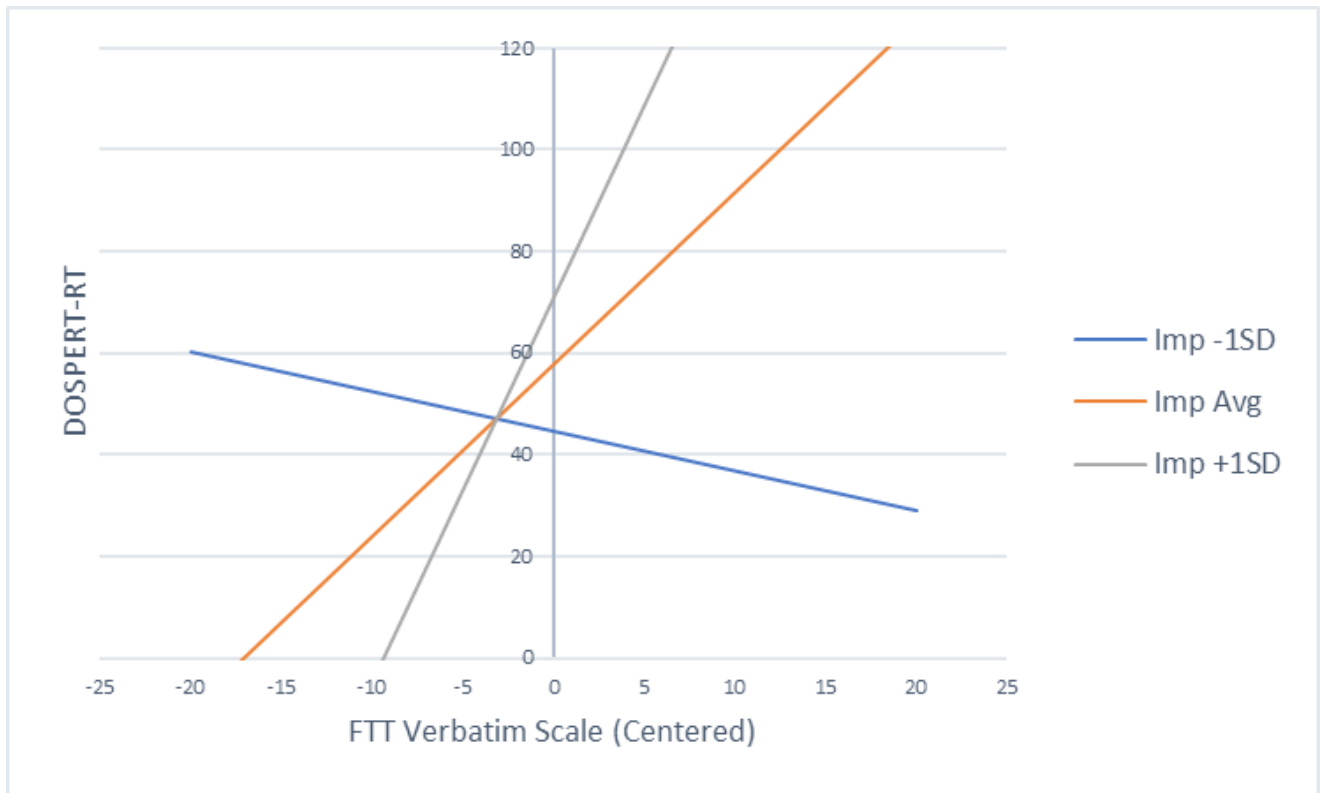*Impulsivity as a Moderator of the Relationship between Gist Principle and Risk-Taking*

Note. The figure shows how the relationship between Gist Principle and RT changes at different levels of impulsivity. Notably, for those with high levels or moderate levels of impulsivity (grey line and orange respectively), risk taking levels decrease significantly when people also have high levels of gist principle. Imp = Impulsivity, 1SD = One Standard Deviation, Avg = Average.

Figure 3

Impulsivity as a Moderator of the Relationship between Verbatim Specific and Risk-Taking

Note. The figure shows how the relationship between Verbatim Specific and RT changes at different levels of impulsivity. Notably, for those with high levels or moderate levels of impulsivity (grey line and orange respectively), risk taking levels increase significantly when people also have high levels of Verbatim Specific. Imp = Impulsivity, 1SD = One Standard Deviation, Avg = Average.