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Abstract

The present study investigated the extent to which financial risk-taking (FRT) perspectives and religiosity influenced an individual's performance on financial decision-making tasks under risk and/or uncertainty. It further investigated the potential to measure this interaction using electro-encephalogram (EEG) assessments through reward-related event-related potentials (P3 and FRN). EEG data were collected from 37 participants undergoing four decision-making tasks comprising the Balloon Analogue Risk Task (BART), Iowa Gambling Test (IGT), Mixed-Gamble Loss-Aversion Task (MGLAT), and MGLA-Success Task (MGLAST). The present study found that BART performance may be affected by an interaction of FRT perspectives and religiosity. The physiological effects of task feedback were also distinguished between religious and non-religious individuals objectively with EEG data. Overall, while religiosity and FRT may not significantly influence IGT and MGLA performance, and interact with BART in a complex way, physiological reaction towards feedback after BART performance appears to be strongly affected by religiosity and FRT perspectives.

Keywords (separated by '-') Financial risk-taking - Religion - Electro-encephalography - Iowa Gambling Task - Balloon Analog Risk Task - Mixed-gambling loss-aversion task

Footnote Information

1 ORIGINAL PAPER



2 **Religiosity, Financial Risk Taking and Reward Processing:**
3 **an Experimental Study**

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8 **Abstract**

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10 and religiosity influenced an individual's performance on financial decision-making tasks
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15 bling Test (IGT), Mixed-Gamble Loss-Aversion Task (MGLAT), and MGLA-Success Task
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17 action of FRT perspectives and religiosity. The physiological effects of task feedback were
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19 data. Overall, while religiosity and FRT may not significantly influence IGT and MGLA
20 performance, and interact with BART in a complex way, physiological reaction towards
21 feedback after BART performance appears to be strongly affected by religiosity and FRT
22 perspectives. **AQ3**

23 **Keywords** Financial risk-taking · Religion · Electro-encephalography · Iowa Gambling
24 Task · Balloon Analog Risk Task · Mixed-gambling loss-aversion task **AQ4**

25 **Introduction** **AQ5**

26 Faith, spiritual beliefs, and religiosity form a significant cultural factor when it comes to
27 individual and social behavior. Religiosity can be conceptualized at both an institutional
28 and individual dimension (Kádár et al., 2023), with its institutional dimension involving
29 individual's attitudes towards and engaging with religious organizations and participating

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30 in events, and its individual dimension involving the belief in deities or a higher power,
31 affection to this higher power, and its effects on an individual's behavior and circumstances
32 (Kádár et al., 2023; Williams et al., 2022).

33 The psychosocial influence of religion in varying contexts has been reasonably estab-
34 lished (Shatenstein & Ghadirian, 1998; Tan et al., 2014). However, the exact influence of
35 religiosity on personal and collective attitudes and the consequent impact on behavior is
36 less straightforward and more complex. Even the interconnection between religiosity and
37 behavior regarding specific fundamental aspects of existence (Baier & Wright, 2001; Law-
38 rence et al., 2016; Simpson & Ramberg, 1992) is largely inconsistent, resulting in non-sig-
39 nificant outcomes on association. The extent and contexts under which individuals adhere
40 to and deviate from religious norms are not yet fully understood.

41 **Religiosity and (Financial) Risk-Taking**

42 In the world of financial matters, these inconsistencies become more pronounced. How-
43 ever, due to the prominent effect that money has on an individual – by providing visible
44 and concretely definable incentives for behavior (Lea & Webley, 2006) – the connection
45 between religiosity and financial attitudes and its consequent real-world outcomes, has
46 workable implications. While there is no concrete theoretical framework to support any
47 direct relationship between religiosity and financial attitudes/behavior, many studies have
48 investigated possible relationships between religiosity and general risk-taking or problem-
49 atic gambling (Calado et al., 2023; Kádár et al., 2023; Kanabar et al., 2024). Findings from
50 these studies may be extrapolated to identify differences between individuals according to
51 their likelihood of engaging with higher-risk financial investment opportunities (e.g., stock
52 market participation).

53 Chan et al. (2014) reported that priming individuals with reminders of divinities encour-
54 aged risk-taking behavior (including financial risks) in contrast to those who were not
55 primed with reminders of divinities. Kupor et al. (2015) reported similar findings. These
56 studies hypothesized that religiosity creates psychological safety nets for individuals to
57 'take a chance' and contradict studies that have suggested that religion acts as an effective
58 deterrent against (financial) risk-taking behaviors (Beyerlein & Sallaz, 2017), but rather
59 deters against immoral behaviors which may involve risk-taking (Kupor et al., 2015). How-
60 ever, Gervais et al. (2020) were unable to replicate these results, thereby suggesting that the
61 association between religious priming and risk-taking was not substantially pronounced.

62 Other studies have associated religiosity with risk aversion in different contexts. Bartke
63 and Schwarze (2008) reported an association between religiosity, religious affiliation, and
64 risk-taking, while reporting a non-significant association between risk-taking and national-
65 ity. Jiang et al. (2015) reported that family firms with religious founders were more risk
66 averse as opposed to their counterparts. Wijaya et al. (2022) reported that a higher level
67 of religiosity was associated with increased risk aversion within the same religious group.
68 Noussair et al. (2013) reported that risk aversion was driven by social aspects of religious
69 membership rather than religious belief, while confirming the association between religio-
70 sity, risk aversion, and religious affiliation.

71 From a problematic gambling perspective, various studies have shown opposite effects
72 of religiosity on problematic gambling, both from the institutional and individual dimen-
73 sion of religiosity. From an institutional dimension, Lam (2006) showed that individuals
74 who participate less frequently in religious activities are more likely to engage in gam-
75 bling activities. However, Toneatto (1999) indicated that adhering to religious beliefs

76 or performing specific religious practices could increase faith in winning, and therefore
77 increase the likelihood of gambling.

78 Other studies indicate that the religious aspects of attending religious services can
79 reduce the likelihood of gambling, as these services often portray gambling and other
80 financial risk-taking behaviors as sinful (Beyerlein & Sallaz, 2017; Casey et al., 2011;
81 Uecker & Stokes, 2016), suggesting that the institutional aspects of religion (such as group
82 identity and norms) may also influence attitudes towards gambling, as seen in other con-
83 texts (Williams et al., 2017). Another institutional factor may be the religious affiliation
84 of an individual, with some religions considering gambling sinful, and other religions not
85 bearing obvious moral sanctions against gambling (Calado et al., 2023).

86 However, there are significant exceptions that further complicate general inferences
87 regarding the relationship between religious affiliation and financial risk-taking (Mutti-
88 Packer et al., 2017). Some religions condemn gambling but will tolerate lottery-based
89 activities where money spent by participants is returned to participants (with a possible
90 gain), or where the profit made by the lottery is used to support the community (Caple &
91 Roddy, 2023; Hassanat & Al Tarawneh, 2015). For participants, these initiatives can blur
92 the lines between what is excessive financial risk-taking (gambling) and investing in com-
93 munities or commodities. In extreme cases, this may lead to individuals investing in exces-
94 sive commodities for the profit of pastors or other members of the religious community
95 (Udechukwu, 2021).

96 Some financial risk-taking behaviors comparable to gambling are also theologically
97 sanitized (Coleman, 2016). Moreover, some religions may not provide explicit guidance
98 on forms of financial risk-taking (e.g., purchasing a luxury car) that could lead to severe
99 losses for a family, leading members of the religious community to follow global trends in
100 these decisions (Arli et al., 2020; Nwankwo et al., 2014). The relationship between religion
101 and institutional norms within religions and their influence on the morality and behavior of
102 individuals is ultimately not straightforward.

103 From an individual dimension, studies have examining religiosity and problematic gam-
104 bling have had mixed findings (Kanabar et al., 2024). While spirituality has shown pro-
105 tective elements and positive contributions towards recovery from substance abuse (Kádár
106 et al., 2023), other studies showed that a religious aspect in recovery therapy may reduce
107 the likelihood of problem gamblers to engage with therapy (Schuler et al., 2016). Increased
108 religiosity has also been shown to increase the likelihood to participate in gambling activi-
109 ties (Williams et al., 2022). This is often explained through the illusion of control frame-
110 work (Browne et al., 2019; Calado et al., 2023), with problem gamblers believing that with
111 the help of divine or spiritual interventions, they can control gambling outcomes (Toneatto,
112 1999). A further complication is the aspect of religious struggles and loss of faith, where
113 individuals who are struggling with their religion may become more prone to engage with
114 activities described as sinful within their religious framework including gambling (Grant
115 Weinandy & Grubbs, 2021).

116 Another aspect of the individual dimension of religiosity and wealth-seeking behavior
117 arrives from the standpoint of reciprocal altruism. This refers to a behavior that enables
118 individual organisms to indulge in behaviors that are not immediately advantageous (cost
119 incurrence), in expectation of a potential advantage (recompense) in the foreseeable future
120 (Trivers, 1971).

121 While it is difficult to arrive at a cost-benefit balance on an evolutionary basis, recip-
122 rocal altruism serves as an attempt to explain a range of behavioral conundrums such as
123 symbiosis and social cooperation – particularly in non-human primates and humans (Kur-
124 zban et al., 2015; Trivers, 2006) – which in turn may help understand specific decisions

125 under risk. Bulbulia (2004) hypothesized that religion mediates between social cohesion
126 and reciprocal altruism, thereby explaining ‘costly’ religious behaviors (such as pilgrim-
127 age, donations) that are economically disadvantageous to an individual. A direct example
128 that bridges the worlds of faith and finance is prosperity gospel, a religious concept which
129 is based on the idea that monetary donations to a divine object will result in monetary
130 rewards through divine sanction (Bowler, 2018).

131 Hobson et al. (2021) identified an interplay of factors culminating in the high-risk deci-
132 sion outcome amongst individuals who engage with prosperity gospel. These include
133 heightened optimistic bias, high arousal positive effect, and ‘financial risk-taking’ – all
134 cognitive processes repeatedly associated with gambling (a financial risk-taking activ-
135 ity) which have been reported in several studies (Cummins et al., 2009; Delfabbro, 2004).
136 However, reciprocal altruism alone may not be a sufficient causal link for theorizing an
137 association between financial risk-taking (FRT) and religiosity. Other associations have
138 been explored which suggest a combination of interrelated factors.

139 In summary, whichever framework developed for linking religion and religiosity with
140 (financial) risk-taking or gambling is considered, studies investigating these associations
141 have shown inconsistent results (Kanabar et al., 2024). These inconsistent findings may be
142 due to how constructs of religiosity rather than religiosity itself may interact with attitudes
143 and behaviors associated with FRT. This notion is supported by studies by Williams et al.
144 (2022) and Mónico and Alferes (2022), which suggest that approaches to religious faith
145 can influence FRT behaviors. Therefore, it is worth considering that religious belief, as
146 a standalone factor itself, may not be very helpful in understanding the morality of risk-
147 based decisions. This ultimately may help explain the largely inconsistent results across
148 different studies and challenge the rationale of grouping participants under a single defin-
149 ing category of subscribing to religious faith, to analyze the extent towards which religios-
150 ity and (financial) risk-taking are associated. Therefore, it may not be meaningful to sug-
151 gest that all religious individuals have the same risk-taking approach or are influenced by
152 religiosity in the same way while taking a decision under risk. Rather, it may be useful to
153 explore how approaches to religiosity influence risk-taking, and how this relationship is
154 further influenced by factors such as optimism bias and other environmental factors such as
155 the institutional effects of religion – which also vary across religious populations (Saroglou
156 & Cohen, 2013).

157 **Confounding Factors in Religiosity and Financial Risk-Taking**

158 Factors such as socioeconomic drives, culture, history of FRT behaviors, and neurobiologi-
159 cal factors could add further context to what makes individuals susceptible to risky invest-
160 ments or vulnerable to delayed gratification. Such factors may ultimately aid the invest-
161 igation of the association between religiosity and financial risk-taking. For instance, the
162 COVID-19 pandemic influenced gambling prevalence around the world, indicating most
163 gamblers maintaining or decreasing their gambling frequency, but an increase in problem
164 gambling (Brodeur et al., 2021), although most studies in the review collected self-report
165 data. Another study showed a similar increase in gambling among individuals with gam-
166 bling disorders and younger adults, but a reduction in gambling during periods of lock-
167 down (Quinn et al., 2022). However, contrasting findings were reported in studies using
168 actual tracking data supplied by gambling operators (Auer et al., 2023; Auer & Griffiths,
169 2022). These studies showed that gambling among the heaviest gamblers reduced during
170 the initial months of the pandemic. While extant literature on the topic is not sufficiently

171 exhaustive to establish definitive conclusions, the issue of COVID-19 and gambling is mul-
172 tifold. This has a basis in the socioeconomic argument including the economic pres-
173 sures and rising inflation amplified by the pandemic, as well as cognitive factors with some
174 studies arguing that lockdowns increased gambling prevalence amongst problem gamblers
175 through the escapism and excitement offered by online FRT activities during a time of rela-
176 tive social isolation (Håkansson et al., 2020).

177 On the other hand, sociocultural (and sometimes economic and political) factors have a
178 visible and observable impact on religious beliefs and experiences, especially regarding the
179 transmission and development of religious beliefs and experiences (Edgell, 2012). How-
180 ever, these factors do not fully explain the underlying mechanisms contributing to the neu-
181 robiological aspects of religiosity and its subsequent impact on cognition, behavior, deci-
182 sion-making, and mental health. The second challenge is to identify an objective predictor
183 that explains financial risk-taking sufficiently, and then evaluate these measures between
184 cohorts exercising different levels of religiosity. Ideally, the level of religiosity would also
185 be evaluated using objective markers. These objective evaluations can either be achieved
186 through observation when performing relevant tasks and/or collection of neurophysiologi-
187 cal data.

188 Physiological Measurements of (Financial) Risk-Taking and Religiosity

189 To date, most studies have collected data using either functional magnetic resonance imag-
190 ing (fMRI, e.g., Miller et al. (2019)) or EEG while participants perform a risk-related task
191 (Balconi & Angioletti, 2022; Giustiniani et al., 2019; Pornpattananangkul et al., 2019;
192 Schmidt et al., 2018). A study by Giustiniani et al. (2019) found that asymmetry in theta-
193 activity between the right and left hemispheres may reflect an individual's motivation and
194 ability to explore strategies when performing the BART. They did not find a similar cor-
195 relation using the IGT.

196 Pornpattananangkul et al. (2019) investigated P3 response and delta-band activity after
197 each of 120 trials of a mixed-gamble loss-aversion task (MGLAT; Tom et al. (2007)). The
198 study found that expected utility affects P3 and delta-band activity earlier compared to util-
199 ity distance, indicating that individuals will develop decision-making strategies based on
200 motivation earlier compared to those based on conflict. However, no information about
201 religiosity was provided for the those participating in the study, yet this could be a potential
202 factor to determine at what time point (i.e., after how many MGLA tasks) conflict-related
203 decision-making components start affecting EEG activity.

204 In a study evaluating the effect of general anxiety levels on decision-making, Schmidt
205 et al. (2018) measured frontal midline theta (FMT) activity among 20 high and 20 low-
206 anxious individuals performing a risk game (card selection with different odds of success).
207 They reported that individuals with high anxiety played less risky and had stronger FMT
208 activity compared to low anxiety individuals. This suggested that higher anxiety is related
209 to a higher exertion of cognitive control during risky decision-making tasks. In another
210 study, Balconi and Angioletti (2022) showed that N2 event-related potential (ERP) ampli-
211 tudes correlate strongly with Go/NoGo task performance among individuals with higher
212 risk of internet addiction when being exposed to addiction-related background pictures.

213 There is growing evidence to suggest that some regions in the brain, in addition to some
214 neural interconnections, contribute to religiosity or religious experience (Rim et al., 2019).
215 While these regions and interconnections bear other fundamental expressions of human
216 neural functionality, evidence suggests that religious faith is correlated with unique neural

217 activity and in some instances, causally linked. Holbrook et al. (2016) reported that the
218 posterior medial frontal cortex (pmFC) helps integrate information from interconnected
219 regions of the brain and strengthen an individual's commitment to their religious beliefs
220 and group values when they encounter ideological conflicts or threats. Additionally, the
221 study reported that these beliefs are vulnerable to targeted neuromodulation through tran-
222 scranial magnetic stimulation. Holbrook et al. (2020) further reported reduced religious
223 belief among participants with a downregulated pmFC when reminded of a relevant
224 threat (such as death), but not under threat-neutral conditions. Therefore, the pmFC may
225 mediate a threat-response to conflict stimuli, and empirical research examining the issue
226 may be supported by evolutionary perspectives (such as reciprocal altruism and group
227 cooperation).

228 A study by Tenke et al. (2017) evaluated religiosity and spirituality in a cohort over a
229 20-year period and reported (i) early (i.e., childhood) initiations into religiosity with higher
230 EEG alpha readings (posterior resting alpha activity), (ii) change in religious denomination
231 with lower EEG alpha readings, and (iii) no correlation of EEG alpha with later initia-
232 tions into religiosity. Neurobiological evidence has also shown that religion may act as a
233 potential deterrent against some manifestations of depressive disorders (Tenke et al., 2017),
234 with posterior alpha activity also being related to better outcome in depression treatment
235 (Bruder et al., 2008).

236 Religion may also be associated with differences in anatomy such as increased corti-
237 cal thickness and decreased default mode network (DMN) connectivity (Rosmarin et al.,
238 2022). However, it is important to note that the precise roles these correlates play are not
239 fully understood. Therefore, there is insufficient evidence to link neurobiology directly
240 with religion. Moreover, recent studies collecting EEG data in eyes-closed resting state
241 have shown a correlation between increased theta-activity and religious coping with stress
242 (Imperatorii et al., 2020).

243 **Assessment of Financial Risk-Taking Preferences and Performance**

244 Several experimental tasks have been developed to assess (financial) risk-taking prefer-
245 ences and behavior. Most notably, financial risk-taking behavior and the ability to develop
246 risk-taking strategies has been evaluated using the IGT, which involves selecting one out of
247 a set of four decks with higher and lower payoffs/losses (Bechara et al., 1994; Dunn et al.,
248 2006). More specifically, IGT assesses the extent to which an individual can develop a suc-
249 cessful strategy in decision-making, requiring a different assessment strategy for the start
250 and the later stages of the task (Brand et al., 2007).

251 Previous studies have shown that most participants can develop a strategy in choosing
252 decks that lead to limited losses (Bechara et al., 1997; Maia & McClelland, 2004). The task
253 has also been instrumental in providing empirical support for the somatic marker hypoth-
254 esis, a theoretical framework for explaining the neural basis of emotions influencing deci-
255 sion-making (Bechara et al., 2005; Naqvi et al., 2006). Desmeules et al. (2008) reported
256 individual differences in performance on the task, and suggested a high sensitivity to gains
257 or losses from two perspectives: scalar multiplication and valuation by emotion. Although
258 initially used to evaluate decision-making impairments among individuals with neuropsy-
259 chiatric disorders and addictions (Bechara & Damasio, 2002; Cavedini et al., 2002), the
260 IGT also shows variety in abilities within populations not suffering from these disorders
261 (Giustiniani et al., 2015), suggesting IGT performance can be affected by many different
262 physiological and psychological (behavioral) phenomena (Giustiniani et al., 2019).

263 However, no previous study has addressed some of the key reasons underlying indi-
264 vidual differences in decision-making performance that is observed in this task among the
265 general population (Dunn et al., 2006). König (2021) reported that younger adults were
266 more risk averse than their older counterparts in the IGT and Simonovic et al. (2017)
267 showed that participants practicing reflective thinking were more likely to develop appro-
268 priate IGT strategies, indicating that religiosity may mediate IGT performance. Therefore,
269 given these findings, the first hypothesis (H_1) addressed in the present study was: *Different*
270 *individual religiosity levels will affect IGT performance within cohorts with similar finan-*
271 *cial risk-taking perceptions.*

272 Another widely used task for evaluating risk-taking is the Balloon Analogue Risk Task
273 (BART; Lejuez et al. (2002)). In this task, participants are asked to inflate a balloon, with
274 longer inflation times leading to higher profits but also higher likelihood of the balloon
275 bursting and participants losing their earnings. The number of pumps before the balloon
276 bursts is randomized among trials. BART performance has, among others, shown a good
277 correlation with real-world risk-taking among adolescents (Lejuez et al., 2002) and distin-
278 guishes risk-taking behavior between age groups (Wilson et al., 2022), with König (2021)
279 identifying younger participants being more risk-seeking when using the BART compared
280 to older participants. However, it has been argued that the BART suffers from confounding
281 bias, which reduces its ability to determine the extent to which participants are risk-seekers
282 (De Groot, 2020). This indicates that the BART is more a measure of decision-making
283 under uncertainty (De Groot & Thurik, 2018).

284 The BART also assesses propensity for risk-taking, but from the start of the task (Lejuez
285 et al., 2002). Schürmann et al. (2019) used the BART to investigate the association between
286 risk perceptions and risk-taking perception/behavior in a dynamic environment. The results
287 showed the significant role that risk perceptions play in risky behavior and potentially can
288 be used to improve an individual's ability to identify real-world risk-takers. Also using
289 the BART, Lauriola et al. (2014) reported individual differences in risky decision-mak-
290 ing environments, related to differences in individuals' sensation seeking trait, with higher
291 impulsivity on the BART related to higher levels of sensation seeking with a low to moder-
292 ate effect size.

293 A study by Chan et al. (2014) also showed that BART performance is influenced by
294 exposure to texts including references to religious objects or divinities. Kupor et al. (2015)
295 showed that being reminded about a divine entity increased risk-taking on the BART,
296 who also showed lower regard to divinity in the case of negative BART outcomes. Conse-
297 quently, it can be argued that the BART can provide insight into the relationship between
298 religiosity and risk-taking in situations with high uncertainty, and the extent to which
299 religiosity influences decision-making in these situations. Based on this, H_2 was: *Religious*
300 *individuals will show different risk-taking behavior during the BART compared to non-*
301 *religious individuals.*

302 Other tasks for evaluating risk-taking behavior include the Mixed-Gamble Loss-Aver-
303 sion Task (Tom et al., 2007). The MGLAT can determine if decision-making during situa-
304 tions which carry risk are based on motivation (expected utility (Becker, 1968)) or conflict
305 (utility distance) and therefore provide insights into the behavioral mechanisms that drive
306 an individual's decision-making, aligning with the theory of intuitive and reflective judge-
307 ment (Kahneman, 2011; Pornpattananankul et al., 2019). Previous research has argued
308 that religiosity may (i) influence expected utility (Bhuiyan et al., 2018), and (ii) reduce stock
309 market participation (Xu et al., 2022). Therefore, H_3 was: *Individual differences in religi-*
310 *osity levels will affect risk-taking in the MGLAT among cohorts with similar risk-taking*
311 *perceptions.*

312 Electrophysiological Aspects of Financial Risk-Taking and Faith

313 While literature focusing on the association between religiosity and FRT have made empir-
314 ical contributions to a very complex problem hard to measure, a more objectively driven
315 approach may provide further context and help address some of the contradictions within
316 it. A plausible approach towards achieving this is to bridge the objective measures that
317 focus on religiosity and FRT (e.g., EEG), and the subjective measures that focus on religi-
318 osity and FRT (self-report accounts). This approach may suppositionally identify explora-
319 tive theoretical grounds, characterized by their own set of complex empirical challenges.

320 The first recognizable barrier is the neurological correlates that underpin religiosity.

321 While several studies have looked at differences in EEG activity for either religion
322 (Imperatori et al., 2020; Rim et al., 2019; Tenke et al., 2017), or reward feedback (P3,
323 feedback-related negativity -FRN) and other event-related potential characteristics in risk-
324 taking/gambling (Balconi & Angioletti, 2022; Dyson et al., 2018; Giustiniani et al., 2015;
325 Pornpattananangkul et al., 2019), as far as the present authors are aware, the combined
326 effect of religion and risk-taking on EEG activity has not previously been investigated.
327 However, the effect of religiosity on EEG activity is an important factor because a partici-
328 pant's rating of religion and personal religiosity affects their perception to and acceptance
329 of gambling and risk-taking. This may be an important confounder which affects results in
330 EEG assessment on gambling behavior and risk-taking. Therefore, H_4 was: *Differences in*
331 *FRT attitudes and religiosity will affect the amplitude of time-domain electro-encephalo-*
332 *graphic (EEG) signals (P3 and FRN) measured during decision-making task feedback.*

333 Methods

334 Thirty-seven participants (14 male, 23 female) were recruited from the general popula-
335 tion through posters displayed around the first author's university campus and postings
336 on social media (Reddit, LinkedIn). The participants' attitude toward financial risk-taking
337 was assessed using a self-devised scale comprising seven items (Table 1), rated from 1
338 (*strongly disagree*) to 7 (*strongly agree*). These questions were selected such that they pro-
339 vide an idea about the likelihood/intention of a participant to engage with high-risk finan-
340 cial events. Questions combine items from household financial risk-taking questionnaires,
341 such as the likelihood to gamble and household financing (fixed income vs investing)
342 (Wong & Carducci, 1991), and questions related to risk-taking among financially literate
343 individuals who anticipate engaging with investment (e.g., stock markets (Lampenius &
344 Zickar, 2005)). Similar questions have also been used in relating investment management
345 with personality types (Lauriola & Levin, 2001; Mayfield et al., 2008). Participants' level
346 of risk-taking was determined based on median response values over all seven questions,
347 with participants having a median equal to or below 3.0 considered risk-averse, and par-
348 ticipants having a median equal to or above 5.0 being considered risk-taking. Participants
349 with values between 3.0 and 5.0 were considered risk neutral. The FRT-questionnaire had a
350 Cronbach alpha score of 0.729.

351 Religiosity was assessed using the five-item Centrality of Religiosity Scale (Huber
352 & Huber, 2012). This scale includes questions about the frequency of praying and join-
353 ing religious services, as well as the extent to which someone believes a divine entity
354 exists. All items (e.g., "How often do you take part in religious services?") are rated

Table 1 List of items assessing financial risk-taking among participants with ratings

Financial Risk-Taking (FRT) statements.	Ratings						
	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
I like to gamble often.	1	2	3	4	5	6	7
I like to invest in risky ventures.	1	2	3	4	5	6	7
I like to deal with uncertainty.	1	2	3	4	5	6	7
I often like to reinvest even if losses can occur.	1	2	3	4	5	6	7
I prefer investing in one investment rather than diversifying.	1	2	3	4	5	6	7
I prefer risky investments over fixed income.	1	2	3	4	5	6	7
I like to make more money.	1	2	3	4	5	6	7

355 on a five-point scale before calculating overall religiosity levels. Religiosity levels were
356 assessed using thresholds suggested by Huber and Huber (2012), taking the average scores
357 of all five questions, and defining an individual as non-religious (average below or equal to
358 2.0), religious (2.1 to 3.9) or very religious (equal to or above 4.0).

359 Risk-Taking Tasks and EEG Measurements

360 EEG data were collected from participants undergoing four decision-making tasks. These
361 were the Balloon Analogue Risk Task (BART), Iowa Gambling Test (IGT), Mixed-
362 Gamble Loss-Aversion Task (MGLAT) (Bechara et al., 2005; Lejuez et al., 2002; Porn-
363 pattananangkul et al., 2019), alongside a task based on the MGLA, but with participants
364 informed if they had won or lost money after every round (hereafter: MGLA-Success Task
365 [MGLAST]). The experiment order was randomized between participants using a Latin
366 square design. EEG data were collected using a 20-electrode EEG system (Enobio20, Neu-
367 roelectrics, Spain), with electrodes located according to the standard 10–20 system. All
368 tasks were written and controlled through MATLAB (R2020a, Natick, USA) and the Psy-
369 chToolbox-3 add-on software (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997).

370 During the BART, participants were asked to inflate a balloon such that they would
371 gain as much profit as possible while avoiding the balloon bursting. The BART experi-
372 ment was adapted in two ways from standard methods (Lejuez et al., 2002). More specifi-
373 cally, (i) participants only pressed a button to start and stop the inflation, and (ii) a color
374 code was provided distinguishing three types of balloons based on their risk for exploding
375 (green=low risk, amber=medium risk, red=high risk). Participants were not informed
376 about color coding before the experiment. The experiment also included a set of rounds
377 where no profit could be made (grey balloons) and a set of rounds where a fixed profit
378 was made, because the balloon automatically inflated to a concentric circle surrounding
379 it. Every participant completed 100 rounds. EEG data were recorded throughout the task.
380 However, for calculating coherent and grand averages over rounds in which money was
381 made versus those where money was lost, a MATLAB trigger was sent to the EEG data
382 collection software at the time the participant banked their profit, or the balloon burst. This
383 was followed by a two-second delay before starting the next round. Apart from EEG data,
384 inflation time, balloon risk-level, and money won/lost were recorded for each round.

385 The IGT experiment employed a modified IGT in which participants pressed a button
386 to decide to play or pass based on an automatically selected deck (Cauffman et al., 2010).
387 Once a deck was selected, the participant received four seconds to decide. A null decision
388 was recorded if participants did not decide within this interval. After each round, the par-
389 ticipant was shown the result of their decision for two seconds. Null decisions were shown
390 as “passed”. As with the standard IGT, two decks were high-risk/high-profit and two decks
391 were low-risk/low-profit (Bechara et al., 2005). Participants received information about
392 money gained/lost immediately after each of the 120 rounds. EEG data were recorded
393 throughout the experiment, with triggers sent to the EEG system when participants were
394 shown the result of each round. Time before deciding, result, amount of money gained/lost,
395 and deck selected were recorded for each round.

396 For the MGLAT and MGLAST, 81 win-loss combinations were developed, with possi-
397 ble wins ranging from £1 to £9 (steps of £1) and losses ranging from £0.5 to £4.5 (steps
398 of £0.5), leading to 61 epochs in which the win/loss ratio is above 1. Combinations were
399 set up such that each win-loss combination occurred once per participant, with all com-
400 binations randomized between different participants. For each round, participants were

401 first shown how much they could win that round. Participants were given as much time as
402 needed (and at least one second) to memorize this value. After a two-second delay in which
403 participants were asked to focus on a plus (+) sign, participants were shown how much
404 they could lose. Again, participants were given at least one second to memorize the amount
405 and, after another two-second delay, were asked if they would like to take the gamble or
406 not by pressing a keyboard button. For the standard MGLAT, there was a one-second delay
407 before the next round started. For the MGLAST, participants were shown the result of their
408 decision for at least two seconds, after which they continued to the next round. Participants
409 were made aware beforehand that, for each round, they had a 50% chance of winning. EEG
410 recordings were measured throughout the task, with triggers sent at the time the “loss”
411 amount appeared on the screen. For the MGLAST, a second trigger at the time participants
412 were informed about the result for each round was added. For each round, decision, time
413 for deciding, and the amount of money won/lost were recorded.

414 EEG Data Processing

415 The BART EEG data were initially filtered using a 501st order finite-impulse response
416 bandpass filter with cut-off frequencies at 0.01 and 100 Hz. This was followed by re-ref-
417 erencing signals to the average over all electrodes. This was followed by a second band-
418 pass filtering step with cut-off frequencies at 0.1 and 30 Hz. EEG data were then epoched
419 from 200ms before till 800ms after trigger timestamps indicating the end of individual
420 rounds. Epochs in which no profit could be recorded or fixed profits were then discarded,
421 leaving a total of 86 epochs per participant. These epochs underwent baseline correction
422 based on the average EEG amplitude measured in their first 200ms. Epochs reaching values
423 above 100 μ V were considered noise and discarded. Coherent averages, P3 amplitude at
424 Pz, and FRN amplitudes at Cz and Fz were calculated after separating profit banked and
425 balloon burst epochs. P3 was measured as the peak absolute amplitude within the inter-
426 val 300ms–450ms after trigger onset. FRN was measured as the peak absolute amplitude
427 within the interval 150ms–300ms after trigger onset. IGT EEG processing followed a simi-
428 lar approach to BART, with the exception of epochs being separated in groups in which
429 participants had won money versus lost money.

430 MGLAT data processing followed an event-related potential (ERP) procedure adapted
431 from Pornpattananangkul et al. (2019). EEG data were bandpass-filtered and re-referenced
432 to the average electrode as before. Data were epoched from 200ms before to 3s after the
433 loss-screen trigger, with detrending performed on a window of 2s before until 4s after
434 the trigger. Baseline correction for each epoch was performed by subtracting the average
435 amplitude of the first 200ms of each epoch. Epochs with amplitudes above 75 μ V were dis-
436 carded. Epochs were investigated overall, as well as for rounds with a win/loss ratio above
437 and below 1. For MGLAST, additional processing involved extracting epochs from 200ms
438 before until 800ms after triggers identifying when results of decisions were shown to the
439 participant. P3 and FRN amplitudes were measured as described above for the IGT and
440 BART experiments.

441 Data Analysis

442 EEG amplitudes were analyzed using pairwise *t*-tests with Tukey correction, comparing P3
443 and FRN amplitudes for BART data of “profit banked” against “balloon burst” rounds, and
444 for IGT and MGLA-success data comparing “won” versus “lost” rounds.

445 Multivariate analysis of variance (MANOVA) was then conducted to determine the
446 effect of FRT and/or religiosity on EEG (P3/FRN) activity and task (IGT/BART/MGLAT/
447 MGLAST) performance indicators. Before applying MANOVA, multi-collinearity was
448 assessed through variance inflation factor ($VIF < 5$), coefficient of determination ($R^2 < 0.99$)
449 and eigenvalue condition index (< 15). If any of these thresholds were violated, the inde-
450 pendent variable was removed from further analysis. Moreover, equality of covariance
451 matrices among different variable groups was evaluated using Box's test. If this showed
452 high significance ($p < 0.01$), Pillai's trace test was used to assess significance within the
453 MANOVA test. In other cases, Wilk's lambda was used (Tabachnick & Fidell, 2020).

454 Further evaluation involved custom hypothesis tests determining if significant contrasts
455 occur between different religiosity/FRT groups. In cases where these were found, uni-
456 variate tests on estimated marginal means of individual indicators were performed using
457 ANOVA with post-hoc pairwise comparison after Tukey correction. All tests were consid-
458 ered significant at a 0.05 alpha level.

459 Results

460 Based on answers to FRT-related questions, 29 participants were classed as risk-averse
461 (78%), five risk-neutral (14%), and three risk-taking (8%). From a religiosity perspective,
462 14 were classed as non-religious (38%), 13 as religious (35%), and 10 as very religious
463 (27%).

464 Iowa Gambling Task

465 Paired *t*-tests showed significant differences in P3 amplitudes at Pz and FRN amplitudes at
466 Fz and Cz when comparing "won" versus "lost" grand averages ($p < 0.001$). From a per-
467 formance perspective, average decision-making times over all participants changed signifi-
468 cantly (Friedman ANOVA, $p < 0.001$), with participants taking significantly less time to
469 decide during the second, third and fourth set of 30 rounds compared to the first set. Simi-
470 larly, variance in decision-making time varied significantly between the first and other sets
471 (Friedman ANOVA, $p < 0.001$). No significant differences were found in play ratios nor
472 profit made among sets. When comparing different decks, no significant differences were
473 found in decision-making time or play ratios. Profits made varied significantly between
474 high-risk and low-risk decks (ANOVA, $p < 0.001$).

475 MANOVA on EEG signals showed no significant effect of FRT (Pillai's trace,
476 $p = 0.325$), religiosity (Pillai's trace, $p = 0.333$), or the interaction between religiosity and
477 FRT (Pillai's trace, $p = 0.052$). However, there was a significant effect of FRT on perfor-
478 mance for one of the high-risk high-gain decks ($p = 0.033$). Contrast analysis showed that
479 this was driven by a significant contrast in total profit made between risk-averse and risk-
480 taking individuals ($p = 0.008$). ANOVA showed a significant difference in total profits
481 ($p = 0.025$), with risk-taking participants showing significantly higher losses incurred com-
482 pared to risk-averse individuals ($p = 0.028$).

483 Balloon Analogue Risk Task

484 P3 and FRN amplitudes were significantly different between epochs in which partici-
485 pants won (profit banked) versus lost (balloon burst) (paired *t*-tests, $p < 0.001$). MANOVA

486 showed a significant effect of FRT ($p < 0.001$), religiosity ($p < 0.001$), and the interac-
487 tion between FRT and religiosity ($p < 0.001$) on BART EEG parameters. From a religios-
488 ity perspective, this was caused by significant contrasts in FRN amplitudes at Fz and Cz
489 between non-religious and religious participants, alongside significant contrasts in FRN
490 amplitude at Fz between religious and very religious participants. Pairwise tests showed a
491 significantly higher FRN amplitude at Fz for “won” epochs among non-religious individu-
492 als compared to religious individuals ($p = 0.008$) and very religious individuals ($p < 0.001$),
493 and a significantly higher amplitude in religious individuals compared to very religious
494 individuals ($p = 0.03$). Similarly, FRN amplitude at Fz for “lost” epochs was significantly
495 higher for non-religious versus religious individuals ($p < 0.001$) and very religious indi-
496 viduals ($p < 0.001$). FRN amplitude at Cz was also significantly higher for non-religious
497 compared to religious individuals ($p = 0.005$) and very religious individuals ($p = 0.013$) for
498 “won” epochs. For FRT, no significant contrasts between risk-taking levels were observed,
499 but pairwise comparison showed significantly different FRN amplitudes at Fz for “won”
500 epochs between risk-taking and risk-averse individuals ($p < 0.001$) and risk-neutral indi-
501 viduals ($p = 0.007$). Within risk-neutral individuals, significant differences were found
502 between non-religious and religious individuals ($p = 0.002$) and non-religious and very
503 religious individuals ($p < 0.001$).

504 Significantly different FRN amplitudes were also found at Fz for “lost” epochs between
505 risk-neutral and risk-averse individuals ($p < 0.001$) and between risk-neutral and risk-tak-
506 ing individuals ($p < 0.001$). Within risk-neutral individuals, non-religious individuals sig-
507 nificantly differed from religious individuals ($p < 0.001$) and very religious individuals
508 ($p < 0.001$).

509 Risk-averse individuals also showed significantly different means of FRN amplitudes
510 for “won” epochs at Cz compared to risk-neutral individuals ($p = 0.023$). Within risk-neu-
511 tral individuals, non-religious individuals significantly differed from religious individuals
512 ($p = 0.003$) and very religious individuals ($p = 0.007$).

513 The interaction between religiosity and FRT showed significant effect on performance
514 during low-risk BART rounds ($p = 0.017$), but no significant contrasts were found. Pair-
515 wise comparisons showed that, within the religious cohort, risk-neutral individuals had
516 significantly longer average inflation time intervals compared to risk-averse individuals
517 ($p = 0.031$) and risk-taking individuals ($p = 0.044$).

518 For medium-risk BART rounds, significant effects were found for religiosity ($p = 0.039$)
519 and the interaction between religiosity and FRT ($p < 0.001$). The variance in inflation time
520 differed significantly between very religious and religious individuals ($p = 0.008$) and very
521 religious and non-religious individuals ($p = 0.024$) within the risk-neutral cohort.

522 **Mixed-Gamble Loss-Aversion Tasks**

523 No significant differences were found between participants or sub-participant cohorts for
524 the MGLAT and MGLAST for religiosity and FRT perspectives. However, significant
525 effects were found on MGLAT average reaction time (Kruskal-Wallis, $p = 0.021$), and
526 MGLAT winnings, average and variance of reaction time for rounds where the win/loss
527 ratio was above 1 (Kruskal-Wallis, $p = 0.047$) when comparing individuals who performed
528 MGLAT before versus after MGLAST. Overall MGLAST average ($p = 0.034$) and variance
529 of reaction time ($p = 0.006$) also differed significantly between individuals who completed
530 the MGLAT before versus after the MGLAST.

531 Discussion

532 The present study investigated the extent to which financial risk-taking (FRT) perspectives
533 and religiosity influenced an individual's performance on financial decision-making tasks
534 under risk and/or uncertainty. It further investigated the potential to measure this interac-
535 tion using objective (EEG) assessments. Religiosity and FRT perspectives were assessed
536 via the centrality of religiosity scale (Huber & Huber, 2012) and a self-devised FRT ques-
537 tionnaire, respectively.

538 Previous research has shown controversy over the likelihood of religious individuals
539 taking morality-abiding risks compared to non-religious individuals, including circum-
540 stances in which risk-taking was affected by direct or indirect religion-related messages
541 (Chan et al., 2014; Gervais et al., 2020; Kupor et al., 2015). More broadly, it has been
542 argued that higher levels of religiosity, or more frequent interaction with reflective think-
543 ing/spirituality (Simonovic et al., 2017) increase the likelihood of FRT, potentially through
544 similar principles found in religious coping strategies (Kim et al., 2018) and reciprocal
545 altruistic behavior encountered in other aspects of religious beliefs and practices (Bulbulia,
546 2004; Hobson et al., 2021; Trivers, 1971).

547 The present study found that religiosity and FRT may affect performance on BART in
548 a complex interaction, but not performance on IGT and MGLA tasks. However, the find-
549 ings did show that different perceptions on religiosity and FRT were related to different
550 brain activity changes, verified objectively through EEG analysis of data collected during
551 task performance. There now follows a discussion of findings according to each of the four
552 hypotheses.

553 Effects of Religiosity and FRT Perspectives on IGT Performance

554 Results suggested there was no relationship between religious orientation and the develop-
555 ment of risk-averse strategies during the IGT. Therefore, H_1 was not supported. Individu-
556 als who considered themselves to be risk-averse lost less money on high-risk decks, but
557 this was not due to a discrepancy in play ratios compared to risk-taking and risk-neutral
558 individuals.

559 It is often assumed that higher levels of religiosity are indicative of increased time spent
560 on reflective thinking, and as such, results on IGT performance for highly religious individ-
561 uals would be expected to align with those that engage more often with reflection and other
562 forms of spirituality (Simonovic et al., 2017). This does not appear to be the case in the
563 present study. The measure of religiosity used, which extended beyond time spent reflect-
564 ing (praying) by including, for example, belief in the existence of and life intervention by a
565 divinity, did not significantly affect IGT performance, and therefore the ability to develop
566 appropriate strategies for IGT. Moreover, the present study did not find an effect for reli-
567 gious morality on reduced risk-taking. These findings align with the work by Gervais et al.
568 (2020), further contradicting that religiosity, or reference to religiosity, negatively affects
569 risk-taking behavior.

570 Effects of Religiosity and FRT Perspectives on the BART

571 The present study showed an interactive effect of FRT perspectives and religiosity on
572 BART performance. Therefore, H_2 was supported. More specifically, when individu-
573 als were close to risk-neutral, religiosity influenced doubt in deciding the amount of risk

574 that can be taken in situations with high uncertainty (medium-risk balloons). Compared to
575 low-risk (higher certainty of not bursting) and high-risk (higher certainty of bursting) bal-
576 loon, very religious, risk-neutral individuals appear to converge more to extreme behaviors
577 (either short inflation or long inflation time) when the chance of the balloon bursting is
578 difficult to judge. Although not tested, this variation may be caused by results in previ-
579 ous rounds, similar to the win-stay-lose-switch (WSLS) heuristic observed in investment
580 decision-making (Weiss-Cohen et al., 2022). Other reasons may be individuals not under-
581 standing the difference between different balloon colors and therefore failing to develop an
582 appropriate strategy overall, or different emphasis of religiosity (praying, belief in divine
583 intervention) affecting risk-taking decisions differently. In essence, the present study agrees
584 with and extends previous analysis provided by Kupor et al. (2015) that the BART can
585 provide a link between religiosity within situations with high uncertainty, especially among
586 individuals with no strong incentive towards or against risk-taking.

587 **Effects of Religiosity and FRT Perspectives on MGLA Tasks**

588 Although previous research has suggested a potential effect of religiosity on expected util-
589 ity (Bhuiyan et al., 2018), which can be measured using an MGLA task (Pornpattananan-
590 ngkul et al., 2019), the present study showed no significant effects of religiosity or FRT
591 perspectives on MGLA performance. Therefore, H_3 was not supported. However, an effect
592 of chronology between the MGLAT and MGLAST was observed. Individuals performing
593 the MGLAT after the MGLAST showed a shorter average reaction time after receiving a
594 cue for decision-making. MGLA average and variance of reaction time, as well as profit
595 made, for rounds with a win/loss ratio above 1 also decreased. With the MGLAST, the
596 reaction time average and variance increased for individuals who performed MGLAT after
597 the MGLAST. These results mostly appear to indicate increased familiarity with the task.

598 **Measuring Religiosity and FRT Perspectives Using EEG While Performing** 599 **Decision-Making Tasks**

600 Several studies have shown variations in frequency-band EEG activities between religious
601 and non-religious individuals (Imperatori et al., 2020; Rim et al., 2019; Rosmarin et al.,
602 2022; Tenke et al., 2017). Simultaneously, neural bases underlying variation within finan-
603 cial risk-taking have been suggested (Kuhnen & Knutson, 2005; Wu et al., 2012; Zheng
604 et al., 2020) and measured with EEG. These bases have been demonstrated by investigat-
605 ing both frequency-domain perspectives of EEG data (Giustiniani et al., 2015; Leota et al.,
606 2023; Pornpattananangkul et al., 2019); and time-domain event-related potentials (Gu
607 et al., 2018; Pornpattananangkul et al., 2019; Zheng et al., 2020).

608 Religion and spirituality are often considered a potential part of behavioral therapy,
609 whether it is problem gambling (or, more generally, problematic financial risk-taking
610 behaviors (Gavriel-Fried et al., 2020; Griffiths et al., 2016)) or other forms of addictive
611 behavior (Kupor et al., 2015; Rodda et al., 2018), as well as behavioral education (Holt
612 et al., 2009). At the same time, religion is possibly considered by risk-takers (or those
613 addicted) as a safety net against harm (Chan et al., 2014; Clarke et al., 2006). These effects,
614 alongside the possibility of religion itself bearing problematic outcomes (Taylor, 2002),
615 indicate that an understanding of changes in EEG activity will improve understanding of
616 the complex effect of religiosity on (financial) risk-taking. In the present study, attention

617 was paid to time domain-based variation in EEG activity upon receiving feedback in finan-
618 cial decision-making tasks.

619 EEG data collected during IGT showed a significant difference in amplitude between
620 rounds where positive (“won”) versus negative (“lost”) feedback occurred, which is
621 expected based on previous work evaluating the effects of negative feedback on brain activ-
622 ity (Santesso et al., 2012). This effect was not found in the MGLAST, potentially due to
623 losses being limited and therefore not inducing a strong response. Previous studies have
624 shown that MGLA tasks may be useful in detecting different levels of expected utility and
625 utility distance (Pornpattananangkul et al., 2019). The BART results also showed some
626 level of sensitivity against different religiosity and FRT levels. These results concur with
627 previous studies showing an effect on ERP P1 amplitudes in BART tasks with increasing
628 levels of risk (Gu et al., 2018), in the sense that variations in willingness to take financial
629 risks may have a physiological underlying mechanism, which is potentially driven by or
630 co-localized with effects related to exposure, and belief in (and practice of) religious/spir-
631 itual rites. Therefore, H_4 was partially supported.

632 Overall, the mediating effect of religiosity on FRT remains complex. One possible rea-
633 son is the broadness of the religiosity concept, which may lead to different interpretations
634 and perception of risk (Gervais et al., 2020; Kupor et al., 2015). Previous work has sug-
635 gested three dimensions to religiosity (belief, experience and ritual), may affect perceptions
636 on life and life events differently (Tan & Vogel, 2008). Although not tested here, argu-
637 ments could be made that individuals experiencing religiosity through perceptions that a
638 divinity intervenes in their life may look differently to those who join religious services
639 frequently, with the former believing divine entities may provide a cushion and the latter
640 paying more attention to religiously moral behavior in day-to-day activities. This was also
641 reported in Williams et al. (2022) and the findings indicated that supernatural aspects of
642 religiosity predicted risky-taking behavior while social and ritualistic aspects of religios-
643 ity predicted risk-aversion. Therefore, the multidimensionality of religiosity may warrant
644 further and specified investigation despite the usefulness of religiosity as an overarching
645 construct and measure in FRT studies. Hypothetically, stronger belief in supernatural facets
646 of religious faith, such as divine intervention may provide a possible avenue for exploring
647 the ambiguity in the dichotomy between religious individuals who are risk-averse due to
648 religious reasons and religious individuals who are conversely risk-takers due to poten-
649 tially religious reasons (Binde, 2007; Lam, 2006; Mutti-Packer et al., 2017). Moreover,
650 religious tolerance or intolerance towards financial risk-taking is complex and influenced
651 by the varying constructs of morality regarding financial risk-taking as defined by different
652 religious traditions and interpretations of theological doctrine by specific religious institu-
653 tions (Coleman, 2016; Hassanat & Al Tarawneh, 2015). In the present study, non-signifi-
654 cant differences in experiencing religiosity were observed within the religious population.
655 Future studies should focus on the effects of different aspects of religiosity on FRT with
656 consideration for the multidimensionality of religious experiences, as well as the nuances
657 of religious morality surrounding financial risk-taking behavior.

658 Conclusion

659 The present study investigated the potential interaction of religiosity and perspectives
660 on financial risk-taking among individuals based on decision-making task performance
661 and EEG activity measuring the effects of feedback against these tasks. The interaction

662 is driven by the idea that financial risk-taking and religiosity may both be driven by
663 religious coping strategies and reciprocal altruistic concepts. The study showed that
664 BART performance, but not MGLA tasks or IGT performance, may be affected by an
665 interaction of FRT perspectives and religiosity. This interaction can also be observed
666 objectively within EEG data. Overall, while religiosity and FRT may not significantly
667 influence IGT and MGLA performance, and interact with BART in a complex way,
668 physiological reaction towards feedback after BART performance appears strongly
669 affected by religiosity and FRT perspectives.

670

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672 **Data Availability** Data will be made available upon reasonable request.

673 **Declarations**

674 The authors have no relevant financial or non-financial interests to disclose.

AQ7

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