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Abstract

This study aimed to test the psychometric properties of the revised Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ) using factor analyses, as well as relationships with well-established factors of personality – including the mediating role of personality traits between Fight-Flight- Freeze system (FFFS), Behavioral Inhibition System (BIS), and Behavioral Approach System (BAS) subscales. The study recruited 1,813 Libyan participants across three subsamples, ranging in age from 18 to 66, through convenience and snowball sampling methods via online platforms. In three different subsamples, findings revealed a robust RST-PQ six-factor structure, distinguishing FFFS and BIS, alongside four distinct BAS subscales. Discriminant validity was assessed, indicting Moderate/strong correlations between BIS and Negative Emotionality, and BAS subscales and Extraversion. Moreover, associations with psychological symptoms highlighted BIS's correlation with anxiety, depression, and stress, and correlations between BAS subscales and personality traits supported their construct validity. Fit indices for the confirmatory factor analysis (CFA) were χ^2 = 30,944, df = 1,378, χ^2/df = 22.01, CFI = .93, TLI = .92, and RMSEA = .04, indicating an acceptable model fit. Gender differences showed females scoring higher in FFFS, BIS, Reward Reactivity, Impulsivity, and Panic responses. Furthermore, structural equation model revealed that personality traits mediated associations between FFFS and BIS, with BAS subscales showing differential predictive patterns. Additionally, separate scales of Defensive Fight and Panic were validated. This research provides the first validation of the RST-PQ in Arabic and highlights the mediating role of personality traits between FFFS, BIS and BAS subscales. Future studies should focus on cultural comparisons and further investigate the predictive validity of RST-PQ scales across different domains (e.g., clinical and occupational).

Keyword; Personality, Approach, Avoidance, Psychometrics, Mediation Role.

Highlights

- RST-PQ validated with six-factor structure: FFFS, BIS, and four BAS subscales.
- BIS correlates with Negative Emotionality, BAS with Extraversion support discriminant validity.

- BIS associated with anxiety, depression, stress, BAS subscales support construct validity.
    - Females score higher on FFFS, BIS, Reward Reactivity, Impulsivity, and Panic.
- Personality traits mediate FFFS, BIS, and BAS; Defensive Fight, Panic scales validated.

1. Introduction

The motivation to approach rewards and avoid threats are fundamental aspects of individual personality, with significant implications across various domains, such as work, education, and health (Blay et al., 2021; Corr &Cooper, 2016; Krupic et al., 2021; Walker et al., 2017). Understanding and assessing between-individual differences in these motivations are paramount goals in personality research (Corr & McNaughton, 2012; Corr & McNaughton, 2008). In this regard, the revised reinforcement sensitivity theory (r-RST) has emerged as a leading conceptual framework. It proposes three neuropsychological systems responsible for approach and avoidance[1] motivations: the behavioral approach system (BAS), the behavioral inhibition system (BIS), and the fight[2]-flight-freeze[3] system (FFFS) (Gray & McNaughton, 2000; Gray;1982).

The Fight–Flight–Freeze System (FFFS), an extension of Gray's original fight–flight system (FFS), has undergone revision. In its update form, the FFFS not only encompasses fight and flight response but also include a freeze response to aversive stimuli. Unlike the original FFFS, which focus solely on *unconditioned* aversive stimuli, the revised FFFS is now postulated to be sensitive to all aversive stimuli (Gray,1982)

In terms of more established personality factors, RST posits that individuals with high levels of impulsivity are particularly attuned to reward signals compared to their low-impulsivity counterparts. Conversely, individuals with high levels of anxiety are more responsive to punishment signals relative to those with low anxiety. (Eysenck, 1997). Gray's theory also provided an explanation for Eysenck's observations regarding arousal effects. According to this theory, punishment is inherently more arousing than reward on average. Introverts, who are more sensitive to punishment, consequently, experience greater arousal induction, resulting in a tendency toward heightened physiological arousal (Gray, 1982; Corr & McNaughton, 2008). In contrast to Gray's perspective, Eysenck argued that if reinforcement effects were *influenced by personality*, they were

[1] Avoidance involves evading danger, as seen when individuals choose to flee or withdraw from risky or stressful environments
[2] Fight is the tendency to confront a threat directly, such as when someone reacts defensively in a dangerous situation
[3] Freeze is a common response where the individual becomes immobilized in the face of fear, unable to act, typically in extreme or sudden threats.

primarily a consequence of an individual's arousal level rather than their sensitivity to reward and punishment per se (Eysenck, 1964; Eysenck,1997).

Gray and McNaughton's work further highlights the role of *situational factors* in shaping defensive behaviors. Specifically, the FFFS distinguishes between stimuli that can be avoided (FFFS) and those that must be faced (BIS) (Gray,1982; Gray & McNaughton, 2000). This distinction leads to various defensive behaviors based on perceived threat, such as flight and active avoidance for avoidable stimuli, and fight and freeze for unavoidable ones.

Moreover, human analogues of these animal responses have been successfully modeled, indicating sensitivity to anxiety and fear-reducing drugs (Perkins et al., 2007). However, the FFFS-related 'Fight' component remains challenging to conceptualise and measurement in humans. Researchers have *separated* it from FFFS, BIS, and BAS processes/scales (Blanchard et al., 2001). At a conceptual level, 'Flight' and 'Avoidance' map onto human phobia, while 'Rage/Panic[4]' and 'Freeze' correspond to human panic disorder. These prototypical animal responses have been modelled in human beings with some success (Blanchard et al., 2001; Perkins et al., 2007), but the placement of '*Fight'* and '*Panic'* within this scheme has been a point of contention (Corr, 2008), resulting in the development of *separated scales* for these components.

Despite the theoretical advancements of RST, (Reuter et al., 2015; Smederevac et al., 2014; Balaban et al., 2021; Contreras et al., 2022; Dierickx et al., 2020; Eriksson et al., 2019; Moncel et al., 2023; Pugnaghi et al., 2018; Vecchione & Corr, 2021; Wytykowska et al., 2017), there remains a dearth of comprehensive psychometric measures capturing the revised RST systems. The development of comprehensive measures, such as the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ), offers promising avenues for advancing research in this field (Corr & Cooper, 2016). While the RST-PQ demonstrates favorable psychometric properties, its length poses practical challenges in large-scale surveys and complex experimental designs, as it encompassing facets like flight, active avoidance, freeze, motor planning interruption, risk assessment, obsessive thoughts, behavioral disengagement, reward interest, goal-drive persistence, reward reactivity, and impulsivity (Corr & Cooper, 2016).

[4] Panic refers to overwhelming fear and emotional paralysis, often experienced when a person is faced with an inescapable threat, leading to a feeling of helplessness.

Moreover, while prior research has explored the direct effects of the Fight-Flight-Freeze System (FFFS), Behavioral Inhibition System (BIS), and Behavioral Approach System (BAS) on behavior, less attention has been paid to the potential mediating role of personality traits in shaping these relationships. This study seeks to address these gaps by testing the psychometric properties of the RST-PQ in a Libyan Arabic-speaking population and by examining the mediating role of personality traits in the relationships between FFFS, BIS, and the BAS subscales (Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity).

Our research has three primary objectives:

1. To assess the psychometric properties of the Arabic version of the RST-PQ in a Libyan Arabic-speaking community. In **Study 1**, we explore the factor structure of the full RST-PQ through Exploratory Factor Analysis (EFA).
2. In **Study 2**, we test the factor structure using Confirmatory Factor Analysis (CFA) and examine the validity of the RST-PQ by correlating it with other personality (Big Five Inventory) and psychological symptom (DASS-8) questionnaires. Additionally, we explore the potential mediating role of personality traits in the relationships between FFFS, BIS, and the four BAS subscales (Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity).
3. In **Study 3**, we investigate the factor structure of the Panic and Defensive Fight scales.

Our hypotheses are as follows:

- In subsample 1, we hypothesize that factor structures will emerge through EFA.
- In subsample 2, we anticipate confirming the six-factor structure of the RST-PQ identified by Corr and Cooper (2016) through CFA. Furthermore, we expect personality traits to mediate the association between FFFS and BIS and the four BAS subscales.
- In subsample 3, we expect to confirm the two-factor structure of Defensive Fight (DF) and Panic scales within the Behavioral Inhibition System (BIS) framework. We also expect that DF will not be associated positively to FFFS and BIS and Panic scales.

2. Method

2.1. Participants and procedure.

Three Libyan Arab subsamples were recruited for this study. Subsample 1 comprised 724 participants with a mean age of 23.68 (SD = 5.65), ranging from 18 to 56 years old. The sample consisted of 81% females and 19% males. In terms of social status, 618 were single, 101 were married, and 5 were divorced. Regarding education, 31 had a high school diploma, 646 held a university degree, and 47 had a postgraduate degree. In term of geographical distribution, the majority of participants were from western region (72.7%), followed by eastern region (15.4%), middle region (8.4%), and southern region (3.3%)

Subsample 2 comprised 731 participants with a mean age of 23.04 (SD = 5.38), ranging from 18 to 66 years old. The sample consisted of 83% females and 17% males. In terms of social status, 620 were single, 105 were married, and 6 were divorced. Regarding education level, 23 had a high school diploma, 657 had a university degree, and 51 had a postgraduate degree. In term of geographical distribution, the majority of participants were from western region (77.8%), followed by eastern region (10.8%), middle region (6.8%), and southern region (4.5%)

Subsample 3 comprised 358 participants with a mean age of 24.02 (SD = 6.32), ranging from 18 to 53 years old. The sample consisted of 85% females and 15% males. In terms of social status, 292 were single, 59 were married, and 7 were divorced. Regarding education level, 21 had a high school diploma, 306 had a university degree, and 31 had a postgraduate degree. In term of geographical distribution, the majority of participants were from western region (76.5%), followed by eastern region (14.0%), middle region (7.3%), and southern region (2.2%)

All Participants were Libyan Arabs and recruited via social media platforms (e.g., Facebook, Twitter) and the official websites of various Libyan community organizations and universities nationwide, using the convenience and snowball method. The questionnaire was available online from 21st December 2023 to 5th February 2024. All participants provided informed consent prior to their involvement in the study, and their confidentiality and privacy were rigorously maintained. The research protocol was approved by the researcher

Institutional Review. We affirm our commitment to integrity, transparency, and ethical conduct in all stages of this research endeavour.

2.2. Materials. Participants in three subsamples completed the translated RST-PQ in Arabic, comprising all 65 items. Each item was rated on a 4-point Likert scale, from "not at all" to "highly," based on how accurately it described them. The presentation order of items was randomized for each participant. The complete item list is available in the Online Supplementary material (Appendix A). The RST-PQ confirmed a robust six-factor structure: comprising two unified defensive scales—namely, the fight-flight-freeze system (FFFS), associated with fear, and the behavioral inhibition system (BIS), linked to anxiety—along with four behavioral approach system (BAS) subsclaes: Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity (Corr &Cooper, 2016). Moreover, the RST-PQ includes two distinct scales for Defensive Fight and Panic, aligning with previous research findings (Corr & McNaughton, 2008; Gomez et al., 2022).

The translation process followed established guidelines for questionnaire adaptation (e.g., Beaton et al., 2000). Initially, the forward translation from English to Arabic was independently conducted by the first author and a professional translator. These versions were then compared and merged into a single forward translation. A back-translation into English was carried out by a native Arabic-speaking professor proficient in English. The original and back-translated versions were reviewed by the second author. Finally, the adapted version was piloted with a small sample of 20 individuals to ensure comprehensibility and clarity.

2.3. Other measures.

Participants in three subsamples also completed the Arabic short version of the BFI-2 Five-Factor Model Personality Scale, as validated by Alansari & Alali (2022) based on the original version developed by Soto and John (2017). This scale comprises 30 items designed to assess major personality traits, organized into five factors and 15 facets. These factors include Extraversion (comprising facets such as Sociability, Assertiveness, and Energy Level), Agreeableness (encompassing traits like Compassion, Respectfulness, and Trust), Conscientiousness (including facets such as Organization, Productiveness, and Responsibility), Negative Emotionality (covering Anxiety, Depression, and Emotional Volatility), and Open-Mindedness (encompassing Intellectual Curiosity, Aesthetic Sensitivity, and Creative Imagination). Respondents provided answers to these items using a Likert scale ranging from 1 (Disagree strongly) to 5 (Agree strongly). In the current study,

Cronbach's alpha values for Extraversion, Neuroticism, Agreeableness, Conscientiousness, and Open-Mindedness were 0.56, 0.80, 0.55, 0.73, and 0.60, respectively.

In addition to the BFI-2, participants in all three subsamples also completed the Depression, Anxiety, and Stress Scale (DASS-8) in Arabic. This self-administered tool, developed by Ali et al. (2021), assesses symptoms related to depression, anxiety, and stress. The scale comprises 3 items for anxiety, 3 for depression, and 2 for stress. Participants rated the applicability of each item on a 4-point Likert-type scale ranging from 0 ("did not apply to me at all") to 3 ("applied to me most of the time"). Total scores were computed by summing all item scores and dividing the total by two. Higher scores on the scale indicate a greater severity of symptoms associated with depression, anxiety, and stress. Reliability analysis showed satisfactory internal consistency, with Cronbach's alpha values ranging from $\alpha = 0.60$ to $\alpha = 0.74$ for its subscales and $\alpha = 0.83$ for the overall scale, affirming its reliability in measuring stress, anxiety, and depression.

3. Analytic strategy

We initiated our data analyses in the first subsample with exploratory factor analysis (EFA) to scrutinize the 65-item RST-PQ item pool. The primary aim of these EFAs was to test the factor structure of the items and pinpoint any with deficient psychometric properties. We employed Minimum Residuals (minres) as the estimation method based on Parallel analysis with Promax rotation (Revelle, 2018). Various indices such as the Comparative Fit Index (CFI), Tucker Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) were utilized, where values exceeding $CFI > .95$, $TLI > .90$, and $RMSEA < .05$ were deemed indicative of a favorable fit (Hu & Bentler, 1999; Byrne, 1994). The determination of the number of factors extracted was predicated on the outcomes of a parallel analysis.

In the second subsample, we confirmed the factor structure for the FFFS, BIS, and BAS developed in the first subsample, this time by using the final version of the RST-PQ. For both Confirmatory Factor Analysis (CFA) and Structural Equation Model (SEM), we employed Diagonally Weighted Least Squares Estimation (DWLS). DWLS is a robust estimation method recommended for its reduced biases, particularly when dealing with non-normal data (Di Stefano & Morgan, 2014; Li, 2016).

Given correlations between scales, a model with six correlated factors was tested. Fit indices, including the, Tucker-Lewis Index (TLI), Root Mean Square Error Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMSR), were considered. Acceptable fit was indicated by TLI > .90, RMSEA < .05, and SRMSR < .06. (Kline, 2023; Hu)

In this sample, reliability indicators (i.e., Cronbach's alphas) were computed. Spearman correlations between RST-PQ and the other variables of personality traits and DASS-8 were examined to confirm and assess the validity of the RST-PQ. The Mann-Whitney U test was conducted to compare two different groups.It is crucial for assessing if the means of two populations are similar, especially when there are differences in variances and sample sizes are uneven.

In the same sample, we investigated the mediating role of the five personality traits between FFFS, BIS, and the four BAS subscales using a Structural Equation Model (SEM). The manifest variable for FFFS was formed using scores obtained from the total score of the FFFS scale, while the manifest variable for BIS was established using total scores of BIS scale. The four BAS manifest variables (Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity) were formulated using total scores derived from each of the four subscales: Personality traits manifest variables were formulated using the five dimensions of the Big Five subscales. In the SEM model, personality traits variables served as mediators, and FFFS, BIS were entered as predictors, while the four subscales of BAS were inserted as outcome.

Subsequently, in subsample 3, we evaluated a CFA model encompassing all the RST-PQ items related defensive fight and panic scales separately as recommended in literature. Moreover, Spearman correlations between defensive fight and panic scales and the other variables of personality traits and DASS-8 were examined to confirm and assess the validity of these separated scales.

These analyses were executed using JASP (Version 0.18.3) and jamovi (Version 2.3) software.

4. Results

4.1 Exploratory Dimensionality Assessment. During the exploratory factor analysis (EFA), fifty-six items were initially loaded. In the initial subsample (n = 724), the adequacy of data fit with the minres estimation method with Promax rotation was supported by both the Kaiser-Meyer-Olkin measure (KMO = .90) and

significant Bartlett's statistics ($\chi 2$ = 14653; df = 2080; $\chi 2/df$ = 7.04, $p < .001$). However, the EFA results indicated that model demonstrated *a poor fit* to the data, with a Comparative Fit Index (CFI) of .90, Tucker-Lewis Index (TLI) of .88, and Root Mean Square Error of Approximation (SRMSR) of .03. This model accounted for 90% of the confidence intervals.

The *parallel analysis* results suggested that the seven-dimensional factors could be extracted, loses the comparability with the original instrument see figure 1. Factor 1 primarily consisted of 19 items and Factor 7 of 3 items related to BIS, except for one item (69 FFFS 6: "I am usually one of the first to spot a new opportunity") associated with fight-flight-freeze. Factor 2 successfully loaded 7 items related to goal-driven persistence, while Factor 3 loaded 8 items related to the fight-flight-freeze system. Factor 4 comprised 7 items reflecting reward reactivity, except for item 68IMP "I am usually one of the first to spot a new opportunity," which related to impulsivity. Factor 5 consisted of six items reflecting reward impulsivity, except for one item 45RR "I am usually one of the first to spot a new opportunity," related to reward reactivity. Factor six successfully loaded 5 items related to impulsivity.

Overall, items loaded successfully on the scales of goal-driven persistence, fight-flight-freeze system, and impulsivity. Factors 1 and 7 contained mostly the same items related to BIS, which might be incorporated into the CFA model of subsample 2. Factor 4 successfully loaded all items related to reward reactivity, except for one item related to impulsivity, while, conversely, Factor 5 loaded all items related to reward impulsivity, except for one item related to reward reactivity. These items in subsample 2 could be incorporated into their suitable scales.

The EFA comprising the 56 items seemed to be applicable in the preliminary analysis of the second subsample. Factor loadings for the 56 items are shown in Table 1. Items that did not load under -.30 were eliminated, and we preferred to keep testing the three items that did not load on their designated factor for the CFA in the second subsample, as we expect a *better goodness of fit* for these items in the CFA of subsequent Study 2. The final Arabic version of the RST-PQ is provided in the supplemental material.

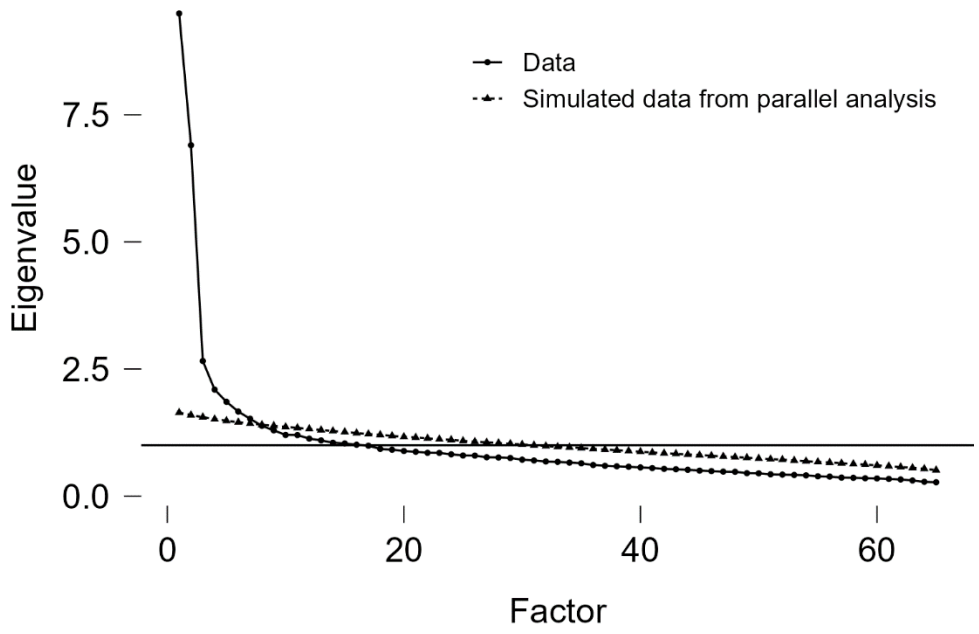


Fig. 1 Results from Parelle analysis shows seven factor structure.

Table 1 Factor Loadings for Exploratory Factor Analyses (EFA) of RST-PQ 56 Items in subsample 1

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Q2BIS	.70						
Q80BIS	.67						
Q62BIS	.67						
Q41BIS	.65						
Q21BIS	.62						
Q75BIS	.60						
Q42BIS	.59						
Q55BIS	.56						
Q82BIS	.54						
Q56BIS	.54						
Q76BIS	.50						
Q66BIS	.49						
Q37BIS	.46						
Q1BIS	.46						
Q83BIS	.43						
Q74BIS	.42						
Q28BIS	.39						
Q69FFFS	**.34**						
Q23BIS	.32						
Q7BIS	.31						
Q54GDP		.73					
Q84GDP		.69					
Q39GDP		.62					
Q13GDP		.62					
Q5GDP		.51					
Q71GDP		.50					
Q25GDP		.46					
Q10FFFS			.66				
Q52FFFS			.62				
Q60FFFS			.61				
Q81FFFS			.58				
Q64FFFS			.56				
Q61FFFS			.53				
Q78FFFS			.43				
Q24FFFS			.42				
Q38RR				.59			
Q19RR				.49			
Q3RR				.48			
Q47RR				.44			
Q32RR				.39			
Q68IMP				**.34**			
Q4RR				.31			
Q17RI					.62		
Q18RI					.58		
Q40RI					.48		
Q45RR					**.42**		

Q44RI	.40			
Q33RI	.40			
Q36IMP		.60		
Q53IMP		.45		
Q35IMP		.45		
Q48IMP		.45		
Q70IMP		.32		
Q8BIS			.66	
Q11BIS			.66	
Q79BIS			.63	

Note. **Applied rotation method is promax.**

4.2 Internal Structure Analysis: Evidence-Based Findings

Initially, we assessed the 56 items, structuring them according to the psychometric patterns identified in subsample 1. In this subsample 2, we amalgamated Factor 1, consisting of 19 items, and Factor 7, comprising 3 items related to BIS, under one CFA factor. Additionally, we included three items—FFFS69, IMP68, and 45RR—that didn't align with their designated factors into this grouping. This model demonstrated acceptable overall fit statistics: $\chi2 = 35280$; df = 1770; $\chi2/df = 19.93$, $p < .001$; CFI = .91; TLI= .92; RMSEA = .04. All factor loadings exceeded 0.3, except for item Q61FFF which was .16, with most surpassing .50. Furthermore, all manifest factors exhibited significant positive correlations, except for RI, which displayed negative correlations with FFFS and BIS, while DGP was negatively correlated with BIS. Refer to Table 2 for details

In the subsequent model, we examined all 65 items of the RST-PQ and *discarded any items with loadings below .30*. This refined model successfully loaded 60 items, including RI12, RR9, RR30, RR31, IMP29, IMP57, IMP77, and BIS11, and excluding items RI15, BIS41, IMP53, FFF61 and BIS65 (see Table 3). This model also demonstrated improved and acceptable global fit statistics: $\chi2 = 30944$; df = 1378; $\chi2/df = 22.01$, $p < .001$; CFI = .93; TLI= .92; RMSEA = .04. All factor loadings were above .30, with most exceeding .50 and .60. Similarly, all manifest factors in this model were significantly positively correlated, except for RI, which showed a negative correlation with FFFS and BIS, while DGP exhibited a negative correlation with BIS. In this case, we opted to retain the second model. Refer to Table 2 for details

Table 2 Factor Loadings for Confirmatory Factor Analyses (CFA)

Latent	**Items**	**Model 1**	**Model 2**
R	Q12RI- I am a very active person		.61

	Q17RI- I regularly try new activities just to see if I enjoy them	.51	.49
	Q18RI- I get carried away by new projects.	.62	.60
	Q33RI- I take a great deal of interest in hobbies.	.58	.58
	Q40RI- I'm always finding new and interesting things to do.	.71	.69
	Q44RI- I am very open to new experiences in life.	.66	.63
GDP	Q5GDP- I put in a big effort to accomplish important goals in my life.	.53	.52
	Q13GDP- I'm motivated to be successful in my personal life	.65	.65
	Q25GDP- I often overcome hurdles to achieve my ambitions.	.50	.50
	Q39GDP- I feel driven to succeed in my chosen career.	.69	.69
	Q54GDP- I am very persistent in achieving my goals.	.73	.74
	Q71GDP- I think it is necessary to make plans in order to get what you want in life.	.35	.35
	Q84GDP- I will actively put plans in place to accomplish goals in my life.	.61	.61
RR	Q3RR- Sometimes even little things in life can give me great pleasure.	.38	.37
	Q4RR- I am especially sensitive to reward.	.35	.33
	Q9RR- I often experience a surge of pleasure running through my body.		.34
	Q19RR- Good news makes me feel over-joyed.	.57	.55
	Q30RR- I often feel that I am on an emotional 'high'.		.37
	Q31RR- I love winning competitions.		.40
	Q32RR- I get a special thrill when I am praised for something I've done well.	.41	.41
	Q38RR- I get very excited when I get what I want.	.58	.55
	Q45RR- I always celebrate when I accomplish something important.	.45	.45
	Q47RR- I find myself reacting strongly to pleasurable things in life.	.68	.66
IMP	Q23IMP- When nervous, I sometimes find my thoughts are interrupted.	.49	
	Q29IMP- I think I should 'stop and think' more instead of jumping into things too quickly.		.35
	Q35IMP- I sometimes cannot stop myself talking when I know I should keep my mouth closed.		.47
	Q36IMP- I often do risky things without thinking of the consequences.	.44	.41
	Q48IMP- I find myself doing things on the spur of the moment	.47	.41
	Q57IMP- I would go on a holiday at the last minute.		.43
	Q68IMP- I think the best nights out are unplanned.	.37	.34
	Q70IMP- If I see something I want, I act straight away.	.40	.34
FFFS	Q10FFFS- I would be frozen to the spot by the sight of a snake or spider.	.48	.48
	Q24FFFS- I would run quickly if fire alarms in a shopping mall started ringing	.40	.39
	Q52FFFS- I would instantly freeze if I opened the door to find a stranger in the house.	.50	.48
	Q60FFFS- I would run fast if I knew someone was following me late at night.	.54	.53
	Q61FFFS- I would leave the park if I saw a group of dogs running around barking at people.	.30	
	Q64FFFS- I would freeze if I was on a turbulent aircraft.	.5	.54
	Q69FFFS- There are some things that I simply cannot go near.	.47	.47
	Q77FFFS- I would not hold a snake or spider.		.29
	Q78FFFS- Looking down from a great height makes me freeze.	.44	.43
	Q81FFFS- I am the sort of person who easily freezes-up when scared.	.74	.72
BIS	Q1BIS- I feel sad when I suffer even minor setbacks	.55	.55
	Q2BIS- I am often preoccupied with unpleasant thoughts.	.57	.57
	Q7BIS- I sometimes feel 'blue' for no good reason.	.56	.56
	Q8BIS- When feeling 'down', I tend to stay away from people.	.39	.39
	Q11BIS- I have often spent a lot of time on my own to "get away from it all".	.42	.88
	Q21BIS- The thought of mistakes in my work worries me.	.48	.48
	Q23BIS- When nervous, I sometimes find my thoughts are interrupted.	.58	.58
	Q28BIS- I often feel depressed.	.61	.61
	Q37BIS- My mind is sometimes dominated by thoughts of the bad things I've done.	.53	.53
	Q42BIS- People are often telling me not to worry.	.46	.46
	Q55BIS- When trying to make a decision, I find myself constantly chewing it over.	.58	.58
	Q56BIS- I often worry about letting down other people.	.52	.52
	Q62BIS- I worry a lot.	.75	.75
	Q66BIS- It's difficult to get some things out of my mind.	.46	.47
	Q74BIS- When nervous, I find it hard to say the right words.	.58	.58
	Q75BIS- I find myself thinking about the same thing over and over again.	.67	.67
	Q76BIS- I often wake up with many thoughts running through my mind.	.52	.52
	Q79BIS- I often find myself 'going into my shell'.	.48	.48
	Q82BIS- I take a long time to make decisions.	.50	.50
	Q83BIS- I often find myself lost for words.	.62	.62
	Q80BIS- My mind is dominated by recurring thoughts.	.64	.64

4.3 Personality Trait Correlations: Insights from RST-PQ Scales and Gender Differences.

To assess the construct validity of the RST-PQ, we examined its correlations with the well-validated Arabic version of the Big Five personality traits test (BFI-2). As anticipated, the correlations with the five-factor results indicated that the RSTQ models were in line with expectations. Specifically, the Behavioral Inhibition System (BIS) showed a strong positive correlation (.64) with Negative Emotionality, while all Behavioral Approach System (BAS) subscales positively correlated with Extraversion.

Consistent with our hypotheses, the Carver and White (1994) BIS scale positively correlated with the RST-PQ Fear/Flight freeze System (FFFS) (.51), as well as with the BAS scales Responsible Reward (RR) and Impulsive Reward (IMP), while showing negative correlations with Reward Interest (RI) and Goal Drive Persistence (GDP). Moreover, the RST-PQ BIS scale exhibited higher correlations with anxiety (.59), depression (.55), and stress (.49) compared to the FFFS scale (Moncel et al.,2023). Notably, the FFFS factor positively correlated with the BIS scale and Negative Emotionality, as well as anxiety, depression, and stress.

Table 3 displays the intercorrelations between RST-PQ factors and scales, alongside established measures of personality traits.

Table 3 Spearman's Correlations Between RST-PQ, Personality traits and psychological symptoms for subsample 2

Variable	FFFS	BIS	RI	GDP	RR	IMP	O	C	E	A	N	ANX	DEP	ST
1.FFFS	—													
2. BIS	.51 ***	—												
3. Reward Interest	-.07	-.18 ***	—											
4. Goal-Drive Persistence	.06	-.11 **	.57 ***	—										
5. Reward Reactivity	.29 ***	.12 **	.47 ***	.44 ***	—									
6. Impulsivity	.24 ***	.32 ***	.25 ***	.19 ***	.40 ***	—								
7. Open-Mindedness	-.12 ***	.00	.38 ***	.23 ***	.14 ***	.03	—							
8. Conscientiousness	-.06	-.26 ***	.34 ***	.34 ***	.16 ***	-.03	.13 ***	—						
9. Extraversion	-.17 ***	-.32 ***	.39 ***	.37 ***	.22 ***	.18 ***	.19 ***	.23 ***	—					
10. Agreeableness	.11 **	-.06	.04	.10 **	.16 ***	-.10 **	-.03	.29 ***	-.08 *	—				
11. Negative Emotionality	.29 ***	.64 ***	-.24 ***	-.22 ***	-.04	.15 ***	-.03	-.33 ***	-.28 ***	-.16 ***	—			
12. Total Anxiety	.29 ***	.59 ***	-.16 ***	-.17 ***	.01	.14 ***	.07	-.24 ***	-.23 ***	-.07	.43 ***	—		
13. Total Depression	.19 ***	.55 ***	-.28 ***	-.33 ***	-.19 ***	.03	-.00	-.24 ***	-.32 ***	-.11 **	.44 ***	.60 ***	—	
14. Total Stress	.15 ***	.49 ***	-.14 ***	-.10 **	-.07	.12 **	.07 *	-.17 ***	-.12 **	-.09 *	.43 ***	.53 ***	.55 ***	—
16. Age	-.00	-.01	-.03	-.15	-.00	.03	.11 **	-.03	-.02	-.00 *	.00	.00 ***	.02	.00
Mean	26.4	63.2	17.3	23.9	33.2	20.9	19.4	22.0	19.4	23.9	18.4	2.9	3.4	3.2
SD	5.42	11.17	3.77	3.54	4.06	3.43	3.59	3.97	3.23	3.24	4.83	2.22	2.24	1.61
Skewness	-.36	-.40	-.33	-1.2	-.84	-.20	.17	-.37	-.00	-.76	-.12	.76	.69	.11
Kurtosis	-.44	-.44	-.49	1.8	.73	-.21	-.13	-.23	-.03	.92	-.57	.22	-.20	-.77
Alpha	.73	.90	.78	.78	.68	.62	.60	.73	.56	.55	.80	.74	.70	.60

* p < .05, ** p < .01, *** p < .001
Gender; Female =1; Males = 2

Note. N = 731 for all correlations. RST-PQ = Reinforcement Sensitivity Theory of Personality Questionnaire; FFFS = flight–fight–freeze system; BAS = behavioral approach system; RI = Reward Interest; GDP = Goal-Drive Persistence; RR = Reward Reactivity; Imp = Impulsivity; FBI-2 = Five-Factor Model Personality Scale -Arabic version; = Open-Mindedness; C = Conscientiousness; E = Extraversion; A = Agreeableness; NE = Negative Emotionality

Regarding the BAS factors, RI, RR, GDP, and IMP were positively correlated with each other, Extraversion, and Openness, but negatively correlated with Negative Emotionality. However, IMP showed non-significant correlations with openness, agreeableness, and conscientiousness, while positively correlating with Negative Emotionality.

Reward Reactivity showed positive correlations with other BAS scales, Extraversion, openness, agreeableness, and conscientiousness, suggesting a reward-oriented individual with extraverted, open, agreeable, and conscientious traits. However, Impulsivity showed a different pattern, correlating positively with Extraversion but negatively with conscientiousness, openness, and agreeableness.

Overall, the correlations were largely consistent with expectations, highlighting unique associations of FFFS, BIS, and BAS factors with established personality measures. Notably, RST-PQ BIS was highly correlated with anxiety, depression, and stress, indicating its distinctiveness from FFFS.

The Cronbach's α coefficients for the different scales of the Arabic RST-PQ ranged from FFS $\alpha = .73$ to BIS $\alpha = .90$, with RI $\alpha = .78$, GDP $\alpha = .78$, RR $\alpha = .68$, and IMP $\alpha = .62$. These results suggest satisfactory internal consistency across all scales of the RST-PQ. See Table 4

4.4 Gender differences

The Mann-Whitney U test revealed significant gender differences in reward reactivity ($p < .001$, mean: females 33.586, males 23.408), impulsivity ($p = .004$, mean: females 31.508, males 21.116), FFFS ($p < .001$, mean: females 27.409, males 21.233), BIS ($p < .001$, mean: females 64.506, males 56.408), and panic responses ($p < .001$, mean: females 16.126, males 13.017), with females generally scoring higher on these constructs compared to males. However, no significant differences were observed in reward interest, goal-drive persistence, and defensive fight responses.

4.5 Mediation Analysis

The Structural Equation Model (SEM) was tested on the entire subsample 2 (see Fig. 1). It examined the direct and indirect effects of flight/fight freeze System (FFFS) and Behavioral Inhibition System (BIS) on four Behavioral Approach System (BAS) subscales through five personality trait dimensions. The model demonstrated excellent fit [N= 731; $\chi 2$ = 1,558.10, p < .001; CFI = 1.0; TLI = 1.00; RMSEA = 0.00, CI 90% (0.00 – 0.00); SRMR = 0.00]. Additionally, all manifest variables significantly loaded on each other significant with minimum acceptable P. value .05.

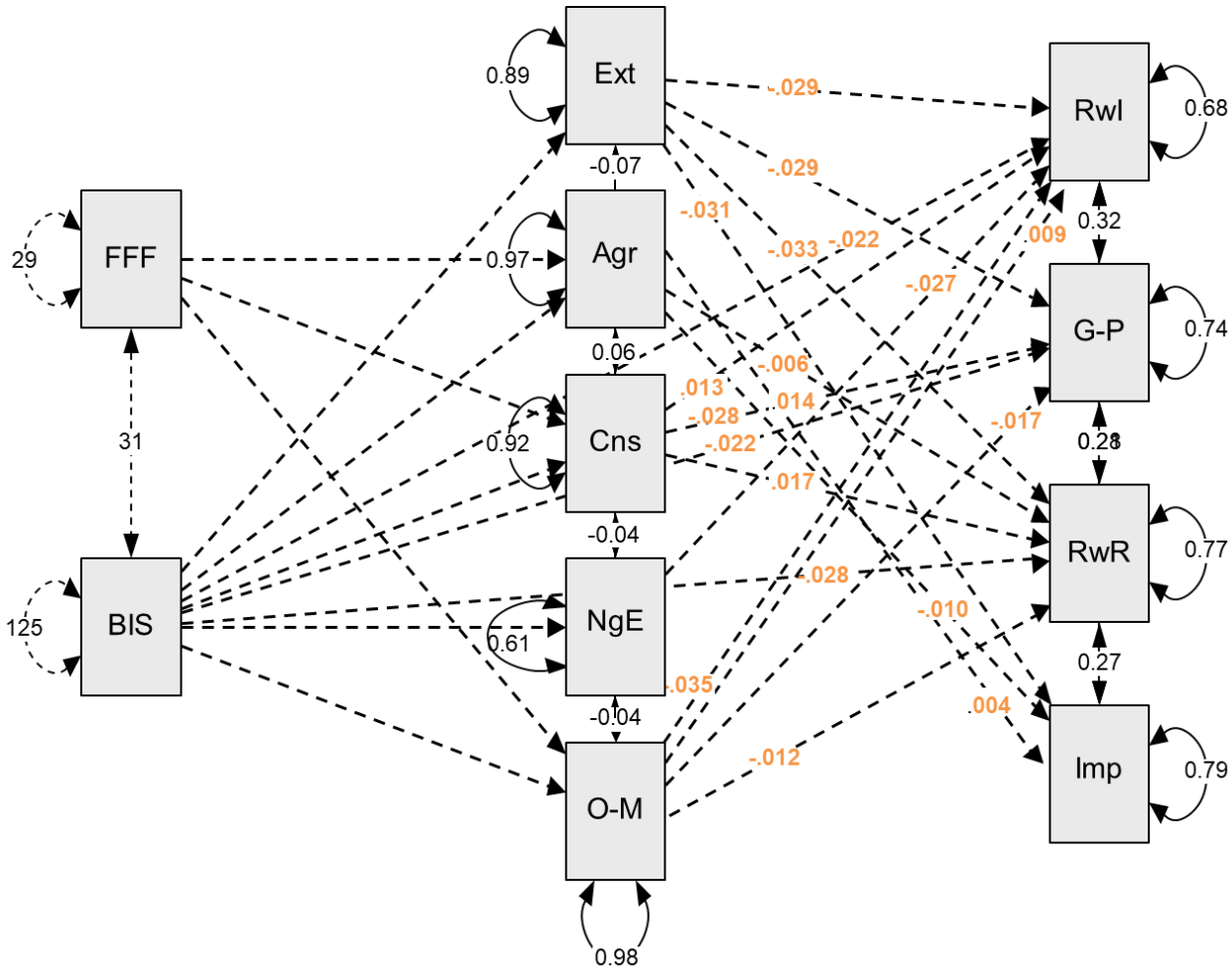
As seen in Figure 2, regarding the mediation of FFFS and BIS on Reward Interest: FFFS positively predicted Reward Interest through Conscientiousness (coefficient = .013; P.034) and negatively through Open-mindedness (coefficient = -.035; p < .001). BIS negatively predicted Reward Interest through Extraversion (coefficient = -.029; p < .001), Conscientiousness (coefficient = -.022; p < .001), and Negative Emotionality (coefficient = -.027; p .003), and positively through Open-mindedness (coefficient = .009; p .04).

For the mediation of FFFS and BIS on Goal-Drive Persistence: FFFS positively predicted Goal-Drive Persistence through Conscientiousness (coefficient = .014; p.03) and negatively through open-mindedness (coefficient = -0.017; p .003). BIS negatively predicted Goal-Drive Persistence through Extraversion (coefficient = -.029; p < .001), Conscientiousness (coefficient = -.022; p < .001), and Negative Emotionality (coefficient = -.028; p .002).

Concerning the mediation of FFFS and BIS on Reward Reactivity: FFFS positively predicted Reward Reactivity through Agreeableness (coefficient = .017; p .007) and negatively through Open-mindedness (coefficient = -0.012; p .019). BIS negatively predicted Reward Reactivity through Extraversion (coefficient = -.033; p < .001), Agreeableness (coefficient = -.006; p .014), and Negative Emotionality (coefficient = -.028; p .006).

Finally, for the mediation of FFFS and BIS on Impulsivity: FFFS negatively predicted Impulsivity through Agreeableness (coefficient = -.010; p .039). BIS negatively predicted Impulsivity through Extraversion (coefficient = -.031; p < .001) and positively through Agreeableness (coefficient = .004; p .050).

Fig.2 shows that personality traits mediated associations between FFFS and BIS, with BAS subscales



Ext= extraversion; Agr=agreeableness; Cns= consciousnesses; Nge= negative emotionality; O-M= Openness. BIS= behavioral inhibition system; FFFS= flight-fight- freeze system. BAS: behavioral approach system= Rwl: reward impulsivity; RR: reward reactivity; Gdp: goal driven persistent; Imp: impuslivity

4.6 Regression Analysis Interpretation

As seen in Figure 3, Reward Interest exhibited positive associations with Extraversion (Estimate =.31, $p < .001$), Conscientiousness (Estimate = .20, $p < .001$), and Open-Mindedness (Estimate = .32, $p < .001$), while negatively associated with Negative Emotionality (Estimate = -.10, $p = .002$).

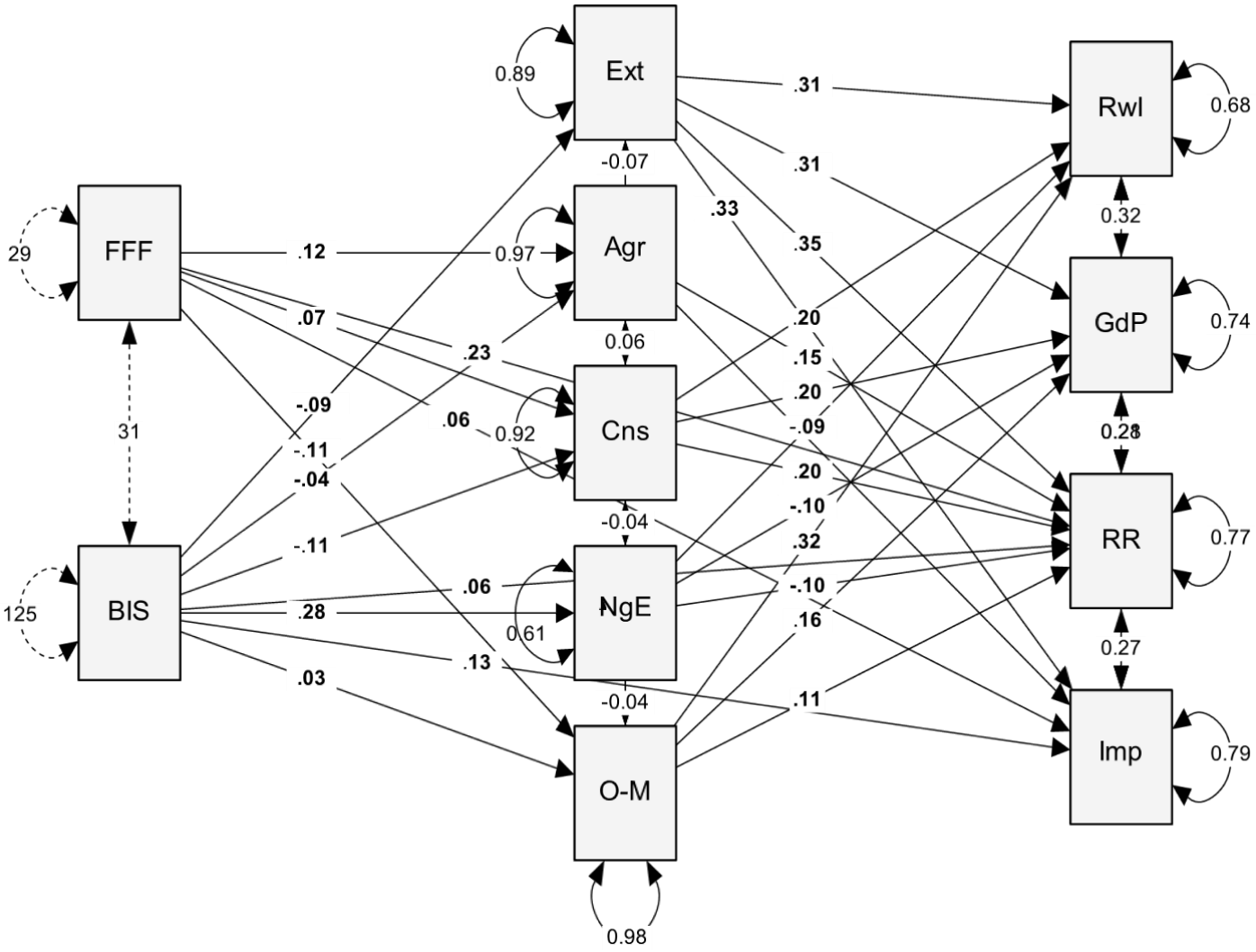
Goal-Drive Persistence demonstrated positive relationships with Extraversion (Estimate = 0.31, $p < .001$), Conscientiousness (Estimate = .20, $p < .001$), Open-Mindedness (Estimate = .16, $p < .001$), FFFS (Estimate = .11, $p < .001$), and a negative association with Negative Emotionality (Estimate = -.10, $p = 0.001$).

Reward Reactivity was positively associated with Extraversion (Estimate = .35, $p < .001$), Agreeableness (Estimate = .15, $p < .001$), Open-Mindedness (Estimate = .11, $p = .003$), FFFS (Estimate = .23, $p < .001$), and BIS (Estimate = .06, $p < .001$), while negatively associated with Negative Emotionality (Estimate = -0.10, $p = 0.006$).

Impulsivity showed a positive association with Extraversion (Estimate = .33, $p < .001$) and negative association with Agreeableness (Estimate = -.09, $p = .021$), and a positive association with FFFS (Estimate = .06, $p = .012$) and BIS (Estimate = .13, $p < .001$).

Furthermore, inter-variable relationships were observed between FFFS and BIS systems with personality traits: BIS negatively predicted Extraversion (Estimate = -.09, $p < .001$), while FFFS positively predicted Agreeableness (Estimate = .12, $p < .001$) and Conscientiousness (Estimate = .07, $p = .023$). Conversely, BIS negatively predicted Agreeableness (Estimate = -.04, $p < .001$) and Conscientiousness (Estimate = -.11, $p < .001$). Additionally, BIS positively predicted Negative Emotionality (Estimate = .28, $p < .001$), while FFFS negatively predicted Open-Mindedness (Estimate = -.11, $p < .001$) and BIS positively predicted Open-Mindedness (Estimate = .03, $p = .043$).

Fig. 3 shows associations of Reward Sensitivity and Goal-Drive Persistence with Big Five Personality Traits and Behavioral Inhibition/Activation Systems



Ext= extraversion; Agr=agreeableness; Cns= consciousnesses; Nge= negative emotionality; O-M= Openness. BIS= behavioral inhibition system; FFFS= flight-fight- freeze system. BAS: behavioral approach system= Rwl: reward impulsivity; RR: reward reactivity; Gdp: goal driven persistent; Imp: impulsivity

4.7 Defensive Fight and Panic

In subsample 3 of our study, we conducted Confirmatory Factor Analysis (CFA) on two separate scales aimed at measuring Defensive Fight and Panic. As introduced earlier, there is evidence suggesting that Defensive Fight construct does not align well with the FFFS (Fight, Flight, Freeze System) and is more likely to correlate with the Behavioral Approach System (BAS). Our objective also encompassed examining how this scale correlates with established measures of personality and psychological symptoms. The results of the CFA model were quite promising. The model demonstrated an excellent fit with the following statistics: N = 358; $\chi 2$ = 1007; df = 66; $\chi 2/df$ = 15.25, $p < .001$; CFI = .97; TLI = .96; RMSEA = 0.04, CI 95% (.02 – .05); SRMR = 0.05. All items from both scales significantly loaded, with a minimum threshold of 0.30, except for items DF6 (.14) and DF14 (.20) pertaining to the Defensive Fight dimension. These items were removed due to their low factor loading. The model showed that defensive fight is negatively associated with Panic (coefficient = -.11), as shown in Figure 4.

When examining the correlations between Defensive Fight and Panic with RST-PQ factors, the five personality traits, and psychological symptoms, interesting patterns emerged (see table 4). The Defensive Fight scale displayed nonsignificant correlations with the FFFS and BIS scales, as well as Panic. However, it showed small to moderate significant positive correlations with each of the four BAS subscales: Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity. The most robust relationship was observed with BAS Goal-Drive Persistence at .34. Additionally, Defensive Fight demonstrated significant positive correlations with Openness, Conscientiousness, and Extraversion personality traits, while not showing significance with Negative Emotionality or Agreeableness. Furthermore, it exhibited nonsignificant correlations with psychological symptoms such as depression, anxiety, and stress.

On the other hand, Panic displayed a strong positive correlation (.74) with BIS, and moderate correlations (.47) with FFFS and two BAS subscales: Reward Reactivity and Impulsivity. However, it did not show significant correlations with Reward Interest or Goal-Drive Persistence of the BAS subscales. Panic was also positively correlated with psychological symptoms, particularly anxiety (.63), as well as Negative Emotionality, Conscientiousness, and Extraversion traits. However, it did not show significance with Open-mindedness and exhibited weak correlations with Agreeableness.

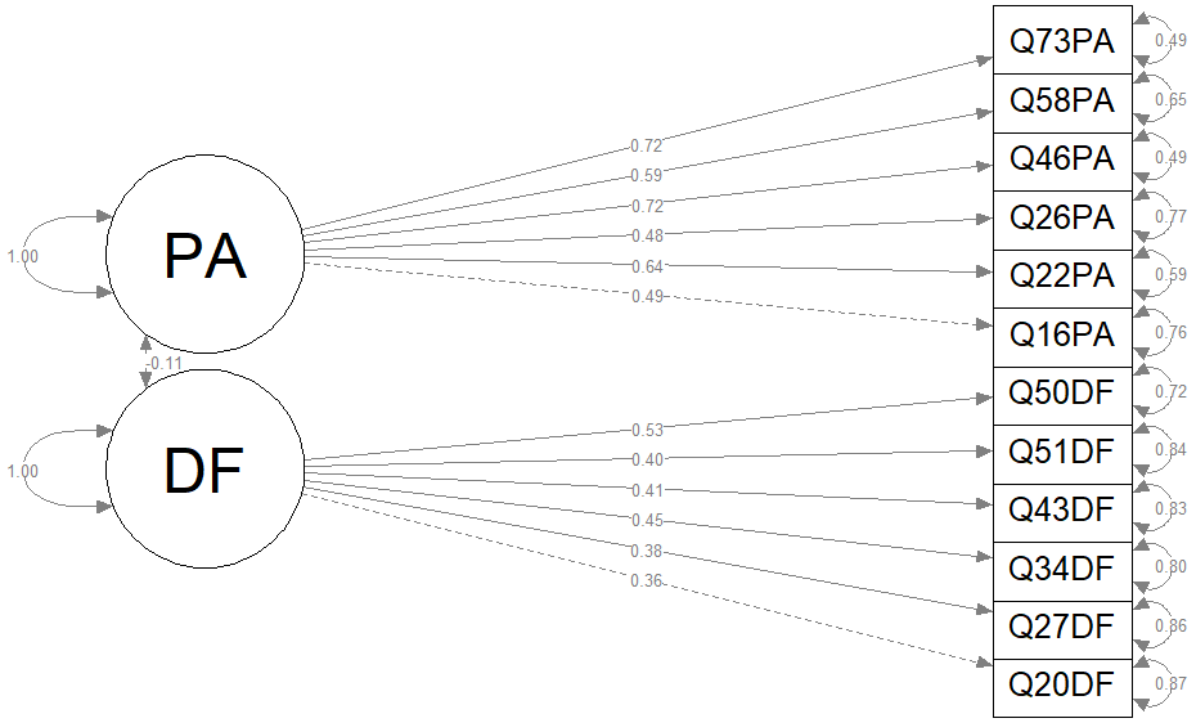
As predicted, the Defensive Fight scale showed stronger correlations with four BAS factors and nonsignificant correlations with FFFS or BIS on the contrary of Panic dimension, supporting the rationale for keeping it separate from these defensive systems.

Table 4 Spearman Correlations Between Defensive fight and Panic with RST-PQ, Personality Traits and Psychological symptoms for subsample 3

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Defensive Fight	—															
2. Panic	-.09	—														
3. FFFS	.04	.47 ***	—													
4. BIS	-.01	.72 ***	.43 ***	—												
5. Reward Interest	.25 ***	-.07	.01	-.11 *	—											
6. Goal-Drive Persistence	.34 ***	-.09	.09	-.12 *	.57 ***	—										
7. Reward Reactivity	.25 ***	.20 ***	.26 ***	.09	.51 ***	.33 ***	—									
8. Impulsivity	.25 ***	.28 ***	.19 ***	.28 ***	.29 ***	.17 ***	.40 ***	—								
9. Open-Mindedness	.18 ***	-.02	-.06	.03	.33 ***	.21 ***	.14 **	.06	—							
10. Conscientiousness	.19 ***	-.17 **	.00	-.24 ***	.34 ***	.46 ***	.10	-.00	.12 *	—						
11. Extraversion	.25 ***	-.15 **	-.09	-.29 ***	.41 ***	.34 ***	.24 ***	.17 **	.12 *	.36 ***	—					
12. Agreeableness	-.04	.12 *	.08	.03	.16 **	.26 ***	.17 ***	.04	-.01	.35 ***	.06	—				
13. Negative Emotionality	-.08	.47 ***	.20 ***	.57 ***	-.20 ***	-.25 ***	-.03	.22 ***	-.04	-.34 ***	-.21 ***	-.12 *	—			
14. Total Stress	-.10	.47 ***	.19 ***	.56 ***	-.13 *	-.13 *	-.02	.14 **	.05	-.14 **	-.09	-.04	.48 ***	—		
15. Total Depression	-.10	.40 ***	.15 **	.52 ***	-.34 ***	-.30 ***	-.19 ***	.02	-.11 *	-.23 ***	-.28 ***	-.11 *	.40 ***	.50 ***	—	
16. Total Anxiety	-.06	.63 ***	.27 ***	.58 ***	-.07	-.12 *	.08	.21 ***	.03	-.19 ***	-.11 *	.05	.44 ***	.56 ***	.55 ***	—
Mean	19.8	15.9	27.1	64.5	17.5	23.9	33.5	21.3	19.4	22.2	19.0	23.9	18.6	3.22	3.57	3.15
SD	2.99	4.30	5.39	11.6	3.78	3.49	4.06	3.33	3.50	4.05	3.26	3.58	4.65	1.75	2.29	2.33
Skewness	-.86	-.15	-.66	-.48	-.50	-1.17	-1.16	-.53	.52	-.19	-.32	-.51	.13	.13	.41	.60
Kurtosis	1.00	-.87	-.07	-.18	-.22	1.67	2.86	.49	-.03	-.47	-.14	.09	-.41	-.92	-.52	-.28

* p < .05, ** p < .01, *** p < .001

Fig. 4 illustrates unstandardized factor loading of the two separate scales Defensive Fight and Panic



8. Discussion

Our primary objective was to validate the revised Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ). As expected in Hypothesis One, exploratory analyses uncovered a robust seven-factor structure, one notably distinguishing between FFFS and BIS, with four distinct BAS subscales: Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity. However, only one factor loaded with three items related to BIS, and three different items (Q69FFFS, Q68IMP, and Q45RR) did not load onto their designated factor, as shown in Table 1.

Confirmatory Factor Analysis (CFA) on a separate subsample supported the original six-factor structure, as shown in Table 2, with acceptable internal reliabilities for RST-PQ scales, delineates two distinct units: the Fight-Flight-Freeze System (FFFS) associated with fear, and the Behavioral Inhibition System (BIS) related to anxiety. Additionally, there are four Behavioral Approach System (BAS) factors: Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity, confirming our Hypothesis Two (Corr & Cooper, 2016; Eriksson et al., 2019; Krupic et al., 2016; Pugnaghi et al., 2018; Wytykowska et al., 2017). Aligning with both theoretical frameworks, and empirical findings, the RST-PQ offers separate scales for Defensive Fight and Panic, as show in Figure 4, where Defensive Fight correlates with BAS factors, while Panic is associated with FFFS and BIS, as corroborated by prior studies (Corr & Cooper, 2016).

In assessing discriminant validity of the Reinforcement Sensitivity Theory Questionnaire (RSTQ) and Personality Questionnaire (DFI-2), the Behavioral Inhibition System (BIS) exhibited a strong positive correlation with Negative Emotionality, while all Behavioral Approach System (BAS) subscales positively correlated with Extraversion, confirming Hypothesis Two. Notably, the FFFS and BIS, IMP positively correlated with Negative Emotionality. However, IMP showed non-significant correlations with openness, agreeableness, and conscientiousness but showed a different pattern, correlating positively with Extraversion.

Regarding the BAS subscales, Reward Interest, Reward Reactivity, Goal-Drive Persistence, and Impuslivity were positively correlated with Extraversion, and Openness, but negatively correlated with Negative Emotionality. Reward Reactivity showed positive correlations with also, agreeableness, and conscientiousness, suggesting a reward-oriented individual with extraverted, open, agreeable, and conscientious traits. These findings align previous research, which similarly reported correlations between RST-PQ scales and personality traits (Corr & Cooper, 2016; Eriksson et al., 2019; Dierickx et al., 2020; Krupic et al., 2016; Pugnaghi et al., 2018; Wytykowska et al., 2017;). Additionally, Goal-Drive Persistence correlated positively with, openness, extraversion, conscientiousness, and agreeableness, indicating a driven, open, extraverted, conscientious, and agreeable individual.

This study also found significant correlations among RST-PQ scales and psychological symptoms. Particularly, the BIS scale exhibited higher positive correlations with anxiety compared to the FFFS scale, additionally, depression and stress were also found to be correlated in this study (Corr & Cooper, 2016; Vecchione & Corr,

2021). Moreover, our analysis revealed significant gender disparities in FFFS, BIS, and Reward Reactivity scores. This aligns with previous research by Dierickx et al. (2020), indicating that females typically exhibit higher scores in these scales. Notably, our study also uncovered that females tend to score higher in Impulsivity and Panic scales, further highlighting gender-based variations in RST-PQ scales. These observed gender differences in FFFS and BIS scores align with traditional gender roles in many Arabic cultures, where females may experience heightened social and familial pressures that contribute to increased sensitivity to stress and anxiety (Ikizler & Szymanski, 2018). These findings underscore the importance of culturally adapted interventions that consider gender-specific experiences in this population.

Interestingly, the findings of this study provide evidence for a mediation. Personality traits, particularly those related to arousal levels (consciousness, agreeableness, openness, and extraversion), mediate the association between brain systems (FFFS, BIS), and the different factors of reinforcement sensitivity, the four BAS subscales (Reward interest, reward reactivity, Goal driven persistent and impulsivity), confirming Hypothesis Two. The model in Figure 2 extends the RST framework by incorporating personality traits, which mediate the relationships between the FFFS, BIS, and BAS subscales. This model is based on Eysenck (1997) and Gray and McNaughton (2000), who theorized that personality traits influence individuals' responses to threats and rewards.

The FFFS exhibited differential predictive patterns, positively predicting Reward Interest and Goal-Drive Persistence through Conscientiousness but negatively through Open-mindedness. Conversely, it positively predicted Reward Reactivity through Agreeableness but negatively through Open-mindedness. In contrast, the BIS displayed a broader range of predictive behaviors, negatively predicting Reward Interest, Goal-Drive Persistence, and Reward Reactivity through various personality traits, with an unexpected positive prediction through Open-mindedness. Additionally, BIS specifically negatively predicted Reward Reactivity through Agreeableness. Regarding impulsivity, both FFFS and BIS converged on their predictions. FFFS negatively predicted Impulsivity through Agreeableness, mirroring BIS's negative prediction through Extraversion and positive prediction through Agreeableness. These findings suggest that reinforcement sensitivity seem to be influenced by personality traits, primarily stemming from an individual's arousal level ‘Personality traits’ rather than solely their sensitivity to reward and punishment per se (Eysenck, 1964; Eysenck,1997).

The outcomes of this study delve into statistical dimensions, offering supplementary perspectives into the intricacies of human personality (Corr & McNaughton, 2008). Eysenck's theoretical framework has demonstrated predictive efficacy in comprehending various facets of behavior and psychological well-being (Corr & McNaughton, 2008). For instance, in this study, traits like Agreeableness and Conscientiousness (aspects of Psychoticism in Eysenck three-dimensional model) emerge as mediators, positively predicting Reward Interest and Goal-Drive Persistence with the Flight Fight Freeze System as the outcome. This suggests that these traits serve as adaptive mechanisms facilitating the pursuit of higher rewards and goals in life. These findings seem to underscore the predictive utility of personality traits in elucidating how they shape behavior and influence outcomes.

Furthermore, this notion is also supported by the positive association between the FFFS and BIS with negative emotionality personality trait, suggesting that individuals high in Neuroticism are more susceptible to experiencing adverse emotions and psychological challenges. Conversely, the positive association between Behavioral Approach System (BAS) factors such as Reward Interest (RI), Reward Responsiveness (RR), and Goal-Drive Persistence (GDP) with extraversion trait indicates that individuals exhibiting higher levels of Extraversion tend to actively seek social stimulation and manifest elevated levels of Reward Sensitivity and Goal-Drive Persistence

The insights from previous research provide valuable perspectives on the physiological substrates in which long-term changes in sensitivity could give rise to personality traits (Gray & McNaughton.2000). The mediation analysis results seem to shed light in the intricate interplay between biological systems and personality traits. Building upon these results, it might be crucial to delve into the underlying physiological mechanisms that contribute to the observed associations (Xue et al., 2024).

In addition to these findings, it is essential to consider the challenges highlighted regarding the relationship between causal and descriptive system of personality (Corr & McNaughton, 2008; Gray, 1972). Factor analysis, which play a fundamental role in personality research, has been criticized for its arbitrary decisions in determine the number and location of factor (Lykken, 1971). This underscores the importance of understanding the relationship between causal systems and behavioural expressions to address the limitations of existing structural models of personality (Gray, 1982).

Moreover, research emphasises the need for a dynamic descriptive model of personality that reflects all levels of the structural hierarchy and how each level relates to each other (Gray, 1982). Integrating these insights into our interpretation of the mediation analysis results seem to enhance our understanding of the intricate interplay between biological systems, personality traits. Reinforcement sensitivity. By acknowledging the challenges and limitations in current approaches to personality research, we can strive towards a more comprehensive understanding of human behaviour and psychological phenomena.

In a third subsample, we tested the separated scales of Defensive Fight (DF) and Panic, revealing that DF related to BAS but not to FFFS/BIS, unlike the Panic dimension, confirming Hypothesis Three. We successfully validated the separate scales of Defensive Fight and Panic, confirming previous findings that Defensive Fight correlates with BAS factors (Corr & Cooper,2016). This underscores the importance of considering Defensive Fight separately from FFFS, BIS, and BAS factors, consistent with previous research (Reuter et al., 2015; Smederevac et al., 2014).

Our analysis confirmed the multidimensional nature of approach behavior, supporting four robust BAS subscales: Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity. These findings align with the theoretical model presented in Figure 3, emphasizing the complexity of approach behavior (Corr & McNaughton, 2008; Corr & Cooper, 2016). Validation evidence included convergent and discriminant correlations with existing personality scales and psychological symptoms. These thematic factors guided the development of the principal domains of FFFS, BIS, and BAS in the RST-PQ.

According to Gray and McNaughton (2000), the FFFS is involved in fight, flight, and freeze responses, while the BIS is related to anxiety and behavioral inhibition (Gomez et al.,2022). The Behavioral Approach System (BAS) regulates goal-directed behavior in response to rewards. The four BAS subscales—Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity—capture different dimensions of approach behavior. Figure 2 reflects the interactions between these systems, where the FFFS and BIS influence the BAS subscales, supported by previous research (Corr & Cooper, 2016).

Since previous research delves into the complexities of personality traits research and the challenges of mapping personality traits to underlying neural systems, and emphasizing of the need for careful validation of scales used in personality research (Cieciuch & Strus, 2017; DeYoung et al.,2007; Markton et al.,2005; McCrae

and Costa, 2008) the results of this research focus on empirically testing the relationship between constructs using statistical modelling techniques, which contribute to the understanding of personality from different perspectives.

This research also aligns with previous studies in acknowledging the challenge of resolving differences in current questionnaire measurement related to Reinforcement Sensitivity Theory (RST) and emphasizing the importance of directly measuring human variation in reinforcement sensitivity to correspond to personality questionnaire (Bainbridge et al., 2022; McNaughton & Gray, 2024) Moreover, research emphasizes the importance of associating psychological traits scales with neuropsychology, suggesting that understanding the neural architecture and neuropsychology of a theory can serve as concrete anchor for personal systems and aid in identifying parallels or redundancy between scales (Bainbridge et al., 2022; McNaughton & Gray 2024).

The results of this study support previous recommendations that underscore the need for rigorous assessment and validation of existing RST questionnaire such as RST-PQ to ensure their alignment with neuropsychological theory and their reliability and validity in measure relevant constructs. (Leue et al., 2022; Corr and Cooper, 2016) Rather than creating new scales, effort should focus on refining and validating existing ones to even to reduce redundancy and improve their utility in research and clinical settings. (McNaughton & Gray 2024)

Practical Application

While the RST-PQ demonstrates promising psychometric properties among Libyan Arabs, its real-world application in clinical and occupational settings remains underexplored. In clinical settings, the RST-PQ can be used to assess personality traits that predispose individuals to mental health issues, such as anxiety, depression, or panic disorders. For instance, individuals with high BIS scores might be more prone to anxiety-related symptoms, suggesting that clinicians could use the RST-PQ to tailor therapeutic interventions. In occupational settings, the questionnaire could help identify personality traits related to stress resilience, motivation, or impulsivity, which are valuable for roles that require high emotional regulation or decision-making under pressure.

Understanding these personality dimensions can help guide interventions that improve mental health outcomes, workplace productivity, and job satisfaction. For example, employees with high BAS scores may thrive in roles that reward goal-driven persistence and high reward sensitivity, while those with higher FFFS scores may require more support in stressful environments. By incorporating the RST-PQ into clinical assessments or workplace evaluations, practitioners can better understand individual differences and develop personalized strategies to enhance well-being and performance.

8.1. Conclusion

In conclusion, this study represents the first validation of the revised Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ) in Arabic and investigates the mediating role of personality traits in the context of RST-PQ studies. These findings are particularly noteworthy because they provide evidence for true mediation between personality traits, arousal levels, and reinforcement sensitivity. This highlights the importance of considering both personality and underlying brain systems when understanding human behavior.

Future research should test the instrument's utility in other Arabic communities, considering diverse cultural interests. Another limitation relates to generalizability, as the subsamples predominantly consisted of female participants. To enhance the reliability of our results, forthcoming studies should aim to recruit more evenly distributed samples in terms of gender and greater age. This would also allow for the examination of gender as a moderating variable in structural equation modeling, enabling researchers to assess its influence while ensuring that the underlying constructs are measured accurately. Additionally, random sampling could be considered for future studies to further strengthen the generalizability of the findings. While evidence for convergent and discriminant validities was provided, further empirical work is needed to establish the predictive validity of RST-PQ scales across various fields, including clinical, experimental, and neuroscientific studies among Arab communities.

Declaration of Conflicting Interests

The authors declare no conflicts of interest that may have influenced the research reported in this paper. The authors have no financial or personal relationships with other people or organizations that could potentially bias the results reported in this paper.

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