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### **Published**

2015

### **Journal Title**

Personality and Individual Differences

### **Version**

Accepted Manuscript (AM)

### **DOI**

[10.1016/j.paid.2014.08.016](https://doi.org/10.1016/j.paid.2014.08.016)

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**Multiple mediators of reward and punishment sensitivity on loneliness**

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## Abstract

The purpose of this paper was to use the revised Reinforcement Sensitivity Theory as a framework to understand loneliness. We expected higher loneliness to be associated with high reward sensitivity and low punishment sensitivity. We tested how reward and punishment sensitivity could affect loneliness by exploring potential mediators including shyness, sociability, communal orientation, and acceptance. We tested 370 participants using an online questionnaire. High punishment sensitivity, but not anxiety, predicted higher loneliness. This association was mediated by higher shyness and lower psychological acceptance. High reward sensitivity was associated with lower loneliness. This association was mediated by lower shyness, higher sociability, higher communal orientation, and higher acceptance. The mediated model with reward and punishment sensitivity accounted for over half the variance in loneliness. Considered in isolation, acceptance predicted over a quarter of the variance in loneliness. These results allow us to identify those at risk of loneliness and, by addressing the mediators, especially acceptance, suggest possible interventions for loneliness.

*Keywords:* Loneliness, acceptance, reinforcement sensitivity, shyness

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### Multiple Mediators of Reward and Punishment Sensitivity on Loneliness

Loneliness is the subjective experience of a lack of social connection and it predicts poor immune function (Pressman et al., 2005), higher stress hormones (Kiecolt-Glaser et al., 1984), suicidal ideation (Stravynski & Boyer, 2001), and depression (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006). Loneliness may be influenced by how one relates to the rewards and punishments of the social world. People vary in their sensitivities to reward and punishment and these individual differences are elaborated by Reinforcement Sensitivity Theory (RST). Using this theory, researchers have found lonely people to be low in reward sensitivity and high in punishment sensitivity (Chang, Kahle, Yu, & Hirsch, 2014). RST, however, was substantially revised in 2000 (Gray & McNaughton, 2000) and previous measures of reward and punishment sensitivity could be tapping other constructs such as anxiety (Heym, Ferguson, & Lawrence, 2008). Thus, the link between loneliness and reward and punishment sensitivity needs to be re-evaluated with measures designed to assess the revised theory. Furthermore, it is unknown what processes mediate the relationship between RST traits and loneliness. The aim of the current paper is to use the revised RST as framework for studying traits associated with loneliness and to examine potential mediators between RST traits and loneliness.

### **1.1. Reinforcement Sensitivity Theory**

The original RST proposed the existence of two motivational systems that regulate approach and avoidance behaviour (Gray, 1982). The Behavioural Activation System (BAS) is sensitive to rewards and regulates approach behaviour whereas the Behavioural Inhibition System (BIS) is sensitive to punishment and involves anxiety. Because social relationships contain powerful rewards and punishments, RST provides a useful framework for studying loneliness. Lonely people, for instance, are high in punishment sensitivity and low in reward sensitivity (Chang et al., 2014). High punishment sensitivity and low reward sensitivity have

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also been linked to poorer social functioning, as measured by both loneliness and low popularity ratings (Kingsbury, Coplan, Weeks, & Rose-Krasnor, 2013). Although these studies are consistent in their findings, both used Carver and White's (1994) BIS/BAS scale, a measure of the original RST. In this scale, BIS taps both fear and anxiety (Heym et al., 2008). There is, however, substantial evidence that fear and anxiety are distinguishable, leading to the revised RST, which split the BIS into a fear system and an anxiety system (Gray & McNaughton, 2000). Thus, it is unknown whether the association between loneliness and original BIS is based on fear, anxiety, or both.

In the revised RST, fear and anxiety are clearly distinguished. The Fight, Flight, Freeze System (FFFS) underlies fear and the revised BIS (r-BIS) underlies anxiety (Gray & McNaughton, 2000). The FFFS reflects punishment sensitivity and is the primary detector of threat. R-BIS detects conflict between FFFS and r-BAS, when both reward and threat are present. The revised BAS (r-BAS) remains relatively unchanged (although see Smillie, Pickering, & Jackson, 2006). The new components of RST can be measured with a new scale (Jackson, 2009) that measures r-BIS and FFFS, distinguishing between anxiety/conflict and fear/punishment sensitivity.

The purpose of the current paper is to test the relationship between the revised RST and loneliness. Because high levels of the original BAS are associated with lower loneliness (Chang et al., 2014) and because social situations hold many rewards including status and affiliation that those high in r-BAS would pursue more strongly (Corr, DeYoung, & McNaughton, 2013), we expect that high r-BAS should predict lower loneliness. High levels of the original BIS are associated with higher loneliness (Chang et al., 2014); however, because original BIS taps fear and anxiety, it is unclear whether loneliness is more related to fear (FFFS) or anxiety (r-BIS). Social situations frequently engage r-BIS because r-BIS manages conflict between approach and avoidance, which emerge frequently in social

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situations (Corr, 2005). For example, talking to people involves approach despite fearing rejection (Corr et al., 2013). Despite r-BIS being heavily engaged in social situations, being high in r-BIS would not necessarily relate to loneliness because the cautious approach typical of r-BIS would not necessarily damage social relationships. In contrast, FFFS is more strongly related to avoidance, which especially if applied to avoiding other people, could be damaging to social connection. Thus, we expect that high FFFS, rather than r-BIS, will predict higher loneliness.

### **1.2. Mediators of Reinforcement Sensitivity**

We sought to identify mediators that would help us understand the association between r-RST traits and loneliness. We identified four potential mediators that relate to the rewards and threats in social situations: shyness, sociability, communal orientation, and acceptance. High punishment sensitivity may increase loneliness through higher shyness because someone who is punishment sensitive may seek to avoid the potential threats inherent in social interactions. Avoiding social interaction is characteristic of shy people, who experience negative affect around others and are withdrawn, a set of tendencies that predict higher loneliness longitudinally (Cheek & Busch, 1981). Shyness overlaps with social anxiety, which is predicted, in the original RST, by high levels of punishment sensitivity and low reward sensitivity (Coplan, Wilson, Frohlick, & Zelenski, 2006). Therefore, shyness should mediate the link between punishment sensitivity (FFFS) and loneliness and between reward sensitivity (r-BAS) and loneliness.

Reward sensitivity may reduce loneliness by increasing sociability. Sociability is defined as the motivation to interact with others and is distinguished from shyness which is discomfort with strangers or acquaintances (Cheek & Buss, 1981). Although sociability shows a moderate negative correlation with shyness, shyness and sociability are distinguishable (Cheek & Buss, 1981), meaning both could independently predict loneliness.

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R-BAS should relate to sociability because high r-BAS individuals should be more motivated by the potential rewards of social interaction. We do not expect a correlation between punishment sensitivity (fear) and sociability because trait fearfulness, measured by items like, “When I get scared, I panic,” correlates with shyness but not sociability (Bruch, Gorsky, Collins, & Berger, 1989). Thus, sociability should mediate the link between reward sensitivity (r-BAS) and loneliness but not between punishment sensitivity (FFFS) and loneliness.

High reward sensitivity may also reduce loneliness through higher communal orientation. Communal orientation reflects helpfulness and a disposition to be concerned with others' welfare (M. S. Clark, Oullette, Powell, & Milberg, 1987). Communal orientation may improve a person's social network and social interactions because others may be more attracted to helpful people. Communal orientation could be predicted by reward sensitivity because people find it rewarding to help others (Weiss, Boyer, Lombardo, & Stich, 1973) and those high in reward sensitivity may experience a greater reinforcing effect from helping others. Thus, communal orientation should mediate the link between reward sensitivity (r-BAS) and loneliness.

Lastly, reinforcement sensitivity may affect loneliness through acceptance. Acceptance is a disposition to accept thoughts and feelings rather than seeking to control or change them (Bond et al., 2011). The most effective way to control feelings in the short-term is to avoid situations linked to these feelings; thus, experiential avoidance is the opposite of acceptance (S. C. Hayes, Strosahl, & Wilson, 2003). High reward sensitivity should encourage approach behaviour, reducing levels of experiential avoidance, increasing levels of acceptance. In contrast, high fear (FFFS) should encourage avoidance, reducing acceptance. Previous research has found high FFFS predicts lower levels of acceptance (D. M. T. Clark & Loxton, 2012).

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High acceptance may improve connection between people and reduce loneliness. Controlling thoughts can be cognitively draining (Klein & Boals, 2001), potentially leaving people impaired in social interactions. Lonely people pay less attention to people in interactions (Jones, Hobbs, & Hockenbury, 1982) and are perceived to be less involved in their conversations (Bell, 1985). Controlling thoughts and feelings may also bias people towards focusing on their inner thoughts and feelings. Self focus increases anxiety during social interactions (Woody, 1996). Thus, acceptance should mediate the link between reward (r-BAS) and loneliness and between punishment sensitivity (FFFS) and loneliness.

### 1.3. Current Study

Previous research found high levels of the original BAS predicted lower loneliness and high levels of the original BIS predicted higher loneliness. However, original BIS conflated fear and anxiety, so we used the revised RST to test whether FFFS (fear) or r-BIS (anxiety) would relate to loneliness. We expected that high FFFS would be associated with higher loneliness because those high in trait fear more likely to withdraw from potential relationships. We expected no relationship between r-BIS and loneliness because those with a tendency to cautiously approach may be more able to continue to seek out companionship even in the face of possible rejection. We expected that high r-BAS would be associated with lower loneliness because r-BAS would motivate pursuit of social rewards. We examined potential mediators between loneliness and FFFS and r-BIS, including communal orientation, shyness, sociability, and acceptance. We expected high sociability, communal orientation, and acceptance would be associated with lower loneliness whereas high shyness would be associated with higher loneliness. We expected that all four mediators would mediate the relationship between r-BAS and loneliness. We expect that only shyness and acceptance will mediate the relationship between FFFS and loneliness. Fear has been previously linked to

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shyness and acceptance, whereas fear has shown no relationship to sociability and there is no reason to expect a relationship between communal orientation and fear.

## 2. Method

### 2.1. Participants and Procedure

We recruited 406 people from Amazon's Mechanical Turk. We restricted participation to US residents who had a high approval rate for previous Mechanical Turk tasks. We excluded 36 people for failing the attention check questions, "Please click 'completely agree' for this question," or "I am currently using a computer (Meade & Craig, 2012)." This left 370 participants with 142 (38.4%) men and 228 (61.6%) women. The sample comprised of 272 (73.5%) Caucasians, 26 (7.0%) African Americans, 25 (6.8%) Asians, and 46 (12.4%) of other races. The average age was 36.30 ( $SD = 13.78$ ). Participants completed the questionnaire online. For all measures, higher scores indicate higher levels of the construct being measured.

### 2.2. Measures

#### 2.2.1. Jackson 5

We measured revised RST traits with the 30-item Jackson-5 (Jackson, 2009). Participants rated their agreement on a 5-point scale from 1 (*completely disagree*) to 5 (*completely agree*). R-BAS was measured with 6 items such as, "I like to do things which are new and different." FFFS was measured with 18 items such as, "I can't help but feel terrified if I see a dangerous animal." R-BIS was measured with 6 items such as, "I want to avoid looking bad."

#### 2.2.2. Shyness and Sociability

Shyness and sociability were measured on a 14-item scale (Cheek & Buss, 1981). Participants rated their agreement on a 5-point scale from 1 (*completely disagree*) to 5 (*completely agree*). Shyness was measured with 9 items such as, "I feel tense when I'm with

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people I don't know well." Sociability was measured with 5 items such as, "I like to be with people."

### **2.2.3. Acceptance**

We measured acceptance with a 10-item scale (Bond et al., 2011). An example item is, "I worry about not being able to control my worries and feelings." Participants indicated the extent to which each statement was true on a scale from 1 (*never true*) to 7 (*always true*).

### **2.2.4. Communal Orientation**

Communal orientation was measured with a 14-item scale (M. S. Clark et al., 1987). Participants rated how characteristic different statements were of them on a 5-point scale, from 1 (*extremely uncharacteristic*) to 5 (*extremely characteristic*). An example item is, "When making a decision, I take other people's needs and feelings into account."

### **2.2.5. R-UCLA Loneliness Scale**

Loneliness was measured with the 20-item revised UCLA loneliness scale (Russell, Peplau, & Cutrona, 1980). Participants rated how often they have various experiences on a 4-point scale from 1 (*never*) to 4 (*often*). An example item is, "I feel left out."

## **3. Results**

The means, standard deviations, and correlations of the study variables are presented in Table 1. FFFS correlated positively with r-BIS and negatively with r-BAS. R-BAS and r-BIS correlated positively. There was a strong negative correlation of loneliness with acceptance and sociability and a strong positive correlation with shyness; over a quarter of the variance in loneliness was accounted for by shyness, sociability and acceptance individually. High r-BAS predicted lower loneliness whereas high FFFS predicted higher loneliness. R-BIS was not associated with loneliness. High r-BAS predicted higher sociability, lower shyness, higher acceptance and higher communal orientation whereas high FFFS predicted higher shyness and lower acceptance. High r-BIS was associated with lower acceptance and higher

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communal orientation; however, controlling for FFFS, r-BIS did not predict acceptance ( $\beta = -.07, t = -1.33, p = .19$ ), but r-BIS continued to predict communal orientation ( $\beta = .16, t = 2.96, p < .01$ ).

We tested the hypothesised model in which r-BAS and FFFS were independent variables, loneliness was the dependent variable, and shyness, sociability, communal orientation, and acceptance were the mediators, using Bias Corrected Percentile Bootstrapping (A. F. Hayes & Preacher, in press). We used the SPSS macro MEDIATE. MEDIATE allows us to test the full mediation model, with multiple independent and mediating variables, testing each mediation path, controlling for each other mediation path. The results of each independent variable and mediator are controlled and independent from the other independent variables and mediators.

The overall mediation model shown in Figure 1 was supported. Table 2 shows the combined effect of both r-BAS and FFFS on the mediators. For all mediators, there was a significant model, showing that r-BAS and FFFS combined predicted all mediators. Most mediators had a moderate amount of variance predicted by r-BAS and FFFS, except for communal orientation which had little of its variance predicted by r-BAS and FFFS. Figure 1 shows the beta weights of all the statistically significant relationships between the independent variables, mediators, and dependent variable. R-BAS was a significant predictor of all mediators. FFFS was a significant predictor of shyness and acceptance, but did not predict sociability ( $\beta = -.04, t = -.91, p = .36$ ) or communal orientation ( $\beta = -.05, t = -.92, p = .36$ ).

The total model with 6 predictors of loneliness was significant,  $R = .73, R^2_{adj} = .52, F(6, 363) = 68.33, p < .01$ . Figure 1 shows the beta weights for the 4 mediators predicting loneliness. Table 3 shows the overall mediation effect for r-BAS and FFFS for the four mediators. The 95% confidence intervals are shown for the overall mediation. If the

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confidence interval excludes zero, a mediated effect is occurring for that independent variable and mediator, controlling for the other independent variables and mediators. R-BAS showed a significant mediation for all four mediators. High r-BAS was associated with lower shyness, higher sociability, higher acceptance, higher communal orientation, and consequently lower loneliness. FFFS showed a significant mediation for two mediators. High FFFS was associated with higher shyness and lower acceptance and consequently higher loneliness. FFFS did not show a mediated effect through communal orientation or sociability on loneliness.

### **4. Discussion**

We tested a multiple mediation model that predicts loneliness. People higher in r-BAS were less lonely. This association was mediated by having higher sociability, higher communal orientation, higher acceptance, and lower shyness. People higher in FFFS were lonelier and this effect was mediated by higher shyness and lower acceptance. R-BIS did not show an overall relationship with loneliness. The overall model predicted over half the variance in loneliness. When considered in isolation, acceptance predicted over a quarter of the variance in loneliness. After controlling for the other predictors, acceptance accounted for over 15% unique variance, whereas shyness accounted for 5% unique variance. Shyness and acceptance showed a strong negative relationship suggesting substantial shared variance between shyness and acceptance. Altogether, this model shows the strength of personality as a predictor of loneliness.

#### **4.1 Reinforcement Sensitivity Theory**

Previous research linked higher loneliness with high levels of original BIS and low levels of original BAS (Chang et al., 2014). The current study was consistent with the BAS finding but found that loneliness was associated with FFFS (fear) but not r-BIS (anxiety). The current study provides further support for the revised RST theory, finding support for the

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distinction between fear and anxiety, finding fear and anxiety predicted different outcomes. Anxiety, not fear, was linked to higher communal orientation. Fear, not anxiety, was linked to lower loneliness and higher shyness. Although anxiety was related to acceptance there was no relationship between anxiety and acceptance after controlling for fear.

The lack of relationship between r-BIS (anxiety) and loneliness contrasts with theorising that links BIS to social situations. R-BIS is active in social situations because social situations are complex and frequently have both approach and avoidance elements (Corr, 2005). Anxious people should be attuned to social comparison and personal failure, motivating attention and cognitive processes aimed at preventing ostracism (White & Depue, 1999). These extra cognitive processes do not appear to be lowering loneliness as our study did not find a link between anxiety and loneliness. In contrast, we found FFFS (fear) was associated with shyness and loneliness. The link between loneliness and fear but not anxiety can be understood by considering how fear and anxiety may affect social behaviour, including meeting new people, applying for a job, or going to a social event. Whereas a fearful person may avoid meeting new people, delay job applications, and avoid social events, increasing their isolation, an anxious person would be more likely to approach social situations cautiously, meeting new people, applying promptly for jobs, and going to social events. Anxious people's tendency to approach cautiously may compensate for any disadvantages of high anxiety.

### **4.2. Interventions to Reduce Loneliness**

The current study explored mediators between RST and loneliness. Understanding the mechanisms underlying the relationship between RST and loneliness can be helpful in designing interventions to reduce loneliness, especially considering that RST traits are considered biologically-based and less malleable to change. However, the mediators—shyness, acceptance, sociability and communal orientation—may provide avenues of change

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for those who struggle with loneliness. Interventions based on teaching individuals to manage risky personality traits like impulsivity and anxiety have been successfully used to reduce drug and alcohol use in adolescents (Conrod, Stewart, Comeau, & Maclean, 2006). Similar personality-targeted interventions may also help address loneliness and other distressing disorders such as social phobia. The strongest predictor of loneliness in our study, acceptance, has been previously shown to be responsive to intervention both in traditional therapy (S. C. Hayes et al., 2003), and self-help workbooks (Muto, Hayes, & Jeffcoat, 2011). Future research could explore the effect of acceptance on social interactions and use existing interventions to increase acceptance to see if such interventions could improve social interactions and reduce shyness. Acceptance may lead to more engagement in social interactions because controlling thoughts impairs cognition (Klein & Boals, 2001), which could impair social interactions. Future research could also examine the effect of acceptance interventions on conversational involvement (e.g. Bell, 1985).

### **4.3. Limitations and Future Research**

The main limitation of this study was that it was cross-sectional, leaving causality uncertain. However, some of the paths specified by the overall model are not plausible in the reverse direction. Both r-BAS and FFFS are innate neurologically driven traits; it would be unlikely for them to be caused by the other factors in this study or a third variable not measured. Thus, the link between RST and loneliness and the link between RST and communal orientation, shyness, sociability, and acceptance should be in the specified causal direction. There is longitudinal evidence that shyness predicts increases in loneliness (Cheek & Busch, 1981). The direction of causality remains uncertain for the link between loneliness and sociability, communal orientation, and acceptance. Further studies can use longitudinal designs to investigate these links. Another potential limitation of the study is that the online sample of Mechanical Turk may not be representative of the population. Many studies,

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however, have found that Mechanical Turk findings replicate those found with other samples (Rand, 2012). All samples can test and possibly falsify an underlying theory, potentially advancing the literature (Mook, 1983). For instance, if an online sample did not find a meaningful distinction between fear and anxiety, this would weaken confidence in the revised RST, regardless of whether this distinction only emerged in a specific population.

### **4.4. Conclusion**

Trait differences in reward and punishment sensitivity predicted motivations and orientations toward social relationships and these orientations predicted loneliness. Greater reward sensitivity predicted lower loneliness through higher sociability, higher communal orientation, higher psychological acceptance, and lower shyness. Greater punishment sensitivity predicted higher loneliness through higher shyness and lower psychological acceptance. There was no relationship between r-BIS and loneliness despite r-BIS theoretically being highly active in social situations. Broadly, this suggests approach tendencies are beneficial for loneliness, avoidance tendencies are harmful loneliness, but sensitivity to conflict between approach and avoidance appears to be neither harmful nor helpful for loneliness.

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## REINFORCEMENT SENSITIVITY AND LONELINESS

Table 1

*Means, Standard Deviations, and Correlations of Study Variables. Values in Parentheses*

*Represent Internal Consistency.*

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8
1. Loneliness	43.45	12.64	(.94)							
2. R-BAS	21.57	4.15	-.31**	(.82)						
3. R-BIS	21.90	4.02	-.02	.28**	(.78)					
4. FFFS	17.46	2.67	.18**	-.13**	.29**	(.71)				
5. Acceptance	47.86	11.94	-.57**	.20**	-.17**	-.38**	(.91)			
6. Shyness	36.63	8.39	.53**	-.30**	.01	.47**	-.50**	(.91)		
7. Sociability	15.45	4.38	-.49**	.41**	.20**	-.01	.23**	-.46**	(.84)	
8. Communal Orientation	49.92	6.70	-.31**	.18**	.15**	.02	.06	-.10	.24**	(.73)

## REINFORCEMENT SENSITIVITY AND LONELINESS

Table 2

*Total Effect of R-BAS and FFFS on the Four Mediators*

Dependent Variable	<i>R</i>	$R^2_{Adj}$	<i>F</i>	<i>df</i>	<i>p</i>
Shyness	.52	.27	68.93	2.00, 367.00	.0000
Sociability	.41	.16	37.27	2.00, 367.00	.0000
Acceptance	.40	.16	36.65	2.00, 367.00	.0000
Communal Orientation	.18	.03	6.22	2.00, 367.00	.0022

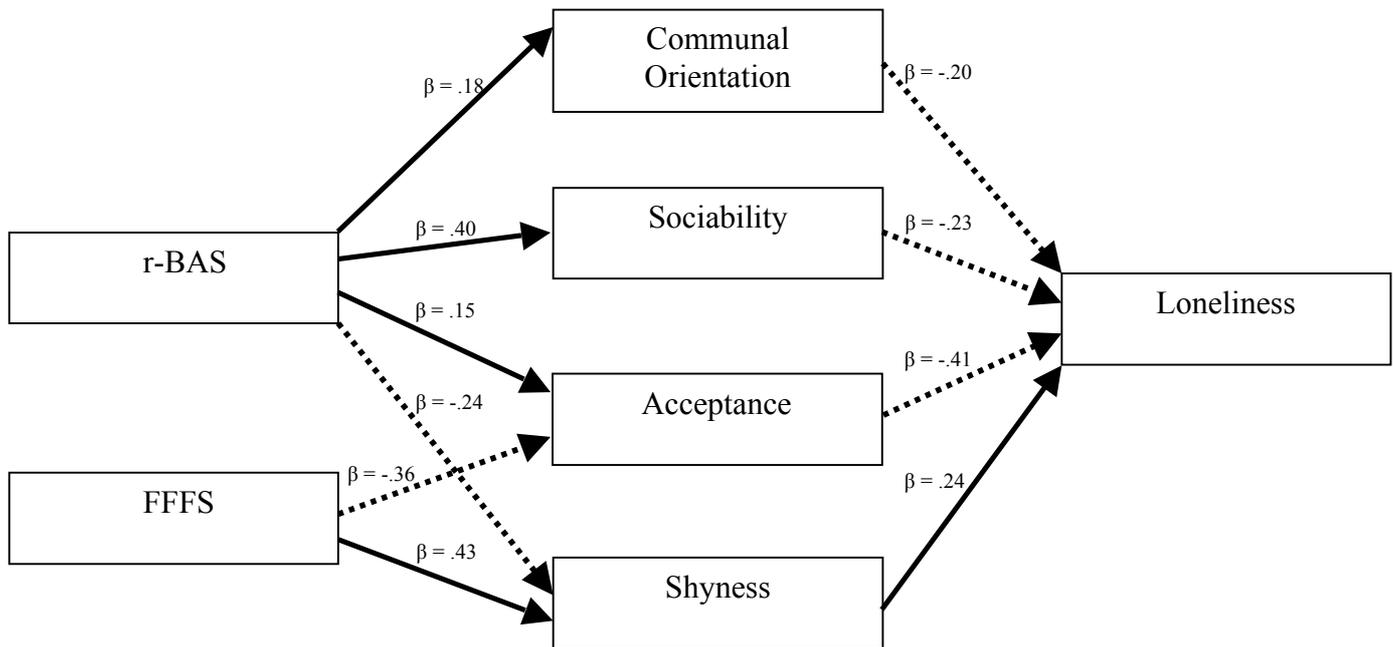
## REINFORCEMENT SENSITIVITY AND LONELINESS

Table 3

*Total Indirect Effects for the Four Mediators.*

		B	s.e.	LLCI	ULCI
Indirect through Shyness					
	r-BAS	-.1752	.0678	-.3188	-.0901
	FFFS	.4916	.1195	.2688	.7366
Indirect through Sociability					
	r-BAS	-.2814	.0678	-.4144	-.1648
	FFFS	.0475	.0641	-.0505	.2225
Indirect through Acceptance					
	r-BAS	-.1876	.0737	-.3346	-.0436
	FFFS	.6984	.1307	.4603	.9735
Indirect through Communal Orientation					
	r-BAS	-.1115	.0429	-.2228	-.0448
	FFFS	-.0456	.0556	-.1650	.0601

*Note.* A confidence interval not containing zero indicates a significant mediation for the mediator and independent variable, controlling for all other mediators and independent variables.



*Figure 1.* Multiple mediation model with six predictors of loneliness. Bold lines represent positive associations while dashed lines represent negative relations. All beta weights are significant,  $p < .01$ . High FFFS predicts higher loneliness, mediated by lower acceptance and higher shyness. High r-BAS predict lower loneliness, mediated by higher communal orientation, higher acceptance, higher sociability and lower shyness.