

ORIGINAL ARTICLE

The Mediating Role of Irrational Beliefs in the Relationship Between Social Cognition and Friendship Relationships

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Ethical Statement

Approval for the research was obtained from Pamukkale University Social and Human Sciences Scientific Research and Publication Ethics committee (02.06.2021 – 68282350/22021/G10) and necessary permissions were obtained from Aydın Provincial Directorate of National Education (E-74083975-605.01-22134143). Upon obtaining both parent and the student consent forms students who volunteered to participate in the study completed the scales online.

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Conflict of Interest

The authors declare that they have no competing interests.

Note

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ABSTRACT

The aim of this study is to examine the mediating role of irrational beliefs in the relationship between social cognition and friendship relationships in adolescents. The sample is 791 (504 female, 287 male) high school students who volunteered for participation. The data were obtained through the Tromso Social Intelligence Scale (TSIS), Peer Relations Scale (PRS), the Shortened General Attitude and Belief Scale (SGABS) and the Personal Information Form. SPSS Process Macro 3.5, developed by Hayes to test the mediating role of irrational beliefs between social cognition and friendship relations has been used. According to the results, social cognition has both direct and indirect relationships with friendship relationships through other downing and demand for fairness subcomponents of irrational beliefs. The findings were discussed considering the relevant literature and theoretical framework, and suggestions were provided for practitioners and researchers.

Keywords: social cognition, irrational beliefs, friendship relationships

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INTRODUCTION

Adolescence is a developmental period during which the cognitive growth rate accelerates, the identity acquisition process is experienced, dynamics of the social roles change and the importance of social relations on self-structure becomes more evident and more complex (Bosma & Koops, 2005; Kilford et al., 2016). In this context, where major structural developmental changes take place almost in every field, social cognition appears to be an important concept that has a decisive role on adolescents' behavior since it guides the evaluations and decisions regarding social interactions (Kilford et al., 2016). The concept of social cognition includes skills such as understanding the intentions of the people we interact with, making inferences from their behaviors, recognizing that others have different mindsets and establishing complex relationships with the environment (Singer & Lamm, 2009). Also, although largely based on the schizophrenia research, social cognition is defined as composing of five basic areas: social perception, social knowledge, attribution bias, theory of mind and emotion perception process (Green et al., 2008).

Social cognitive skills, which continue to develop starting from the first years of life, begin to show noticeable rapid changes and improvements during adolescence as a result of the significant advancements in skills such as perspective taking (Blakemore & Choudhury, 2006). Indeed, increasing complexity of friendships, development of decision-making mechanism, becoming more sensitive to others' opinion and behaviours, constant monitoring and self-reflection indicate that adolescents' social cognitive skills are in the process of major development (Fett et al., 2011; Kilford et al., 2016). Adolescents' increasing level of social cognition provides a ground for adaptive behaviors that facilitate relationships with others (Dodge, 1980) by enabling them to understand the intention behind the feelings, thoughts and behaviors of the others (Crick & Dodge, 1994; Fett et al., 2014); hence, it forms the basis of the successful interactions in the friendship relationships.

It is evident that friendship relationships in adolescence is an important concept that is associated with many important variables such as quality of life, subjective well-being, academic achievement, internet addiction and depression (Çivitci & Topbaşoğlu, 2015; Gilman & Huebner, 2006; Kiran Esen & Gündoğdu, 2010). In addition to its key role, friendship relationships manifest important developmental patterns during adolescence, like social cognition. In this respect, it is important to study the relationships between social cognition and friendship relationships in order to shed light on practices that will support adolescent health.

In light of the current literature, it is expected that friendship relationships would be more successful in adolescents with high social cognition on the ground of the findings that basic elements of social cognition such as perspective taking, perceiving, processing and responding to the emotions appropriately are related to both emotional intelligence and quality and the satisfaction of friendship relationships (Mayer et al., 1999). On the other hand, it is expected that individuals would be more prone to have unrealistic thoughts, develop unrealistic expectations, make erroneous interpretations, and act with irrational beliefs that guide their interpersonal relationships in case of inadequacy in this expected cognitive developmental process (Galassi & Galassi, 1979).

Irrational beliefs include people's strict rules and wishes about themselves and their environment (Ellis, 1993). According to Rational Emotive Behavior Therapy (REBT), basic irrational beliefs such as 'I must be capable, competent and successful in any situation, everyone should be kind and honest with me, my living conditions should be comfortable and advantageous' may lead individuals to maladaptive strategies such as self-downing, other downing, demand for fairness and have unrealistic expectations of success, comfort, and approval (Lindner et al., 1999). Although irrational beliefs are mostly carried from childhood to adolescence, new irrational beliefs can emerge during adolescence due to the development of reasoning ability related to abstract thought and increasing sensitivity to the



others' opinion of the individual (Bernard, 1990; Ellis, 1993).

In the literature, studies on social cognition and friendship relationships in adolescents and young adults generally include criminal or clinical samples (e.g., Short & Simeonsson, 1986; Guy et al., 2017; Green et al., 2008; Botting & Conti-Ramsden, 2008). On the other hand, in the general population, the relationships between social skills and friendship relationships are more commonly examined. In these studies, while friendship relationship is positively correlated with social skills (Desatnik et al., 2020; Rubin et al., 2008), it is negatively associated with irrational beliefs (Ciarrochi, 2004; Çivitci, 2007; Çivitci & Çivitci, 2009). At the same time, there is a negative relationship between social skills and irrational beliefs (Fett et al., 2011; Silverman & DiGiuseppe, 2001; Çivitci & Çivitci, 2009). Although limited, studies examining the relationships between social cognition and friendship relationships found that the ability to take perspective in delinquent aggressors was significantly lower than that of non-criminal adolescents (Short & Simeonsson, 1986), and the level of social cognition was lower in adolescents exhibiting bullying behaviors (Georgiou & Stavrinides, 2008; Kendrick et al., 2012). Furthermore, both social skills and social cognition are important in explaining the problems with friendships, and this pattern is more prominent in adolescents with speech problems than in healthy adolescents (Botting & Conti-Ramsden, 2008). There are also studies showing no relationship between social and emotional problems, including social cognition and friendship relationships (e.g., Forrest et al., 2022). In light of the aforementioned literature, it could be argued that one reason for these contradictory findings between social cognition and friendship relations is that the effects of social cognition on social relations are not directly but through other mechanisms such as irrational beliefs.

To be precise, individuals with low social cognition have negative attitudes towards themselves and others due to their difficulties in understanding, processing and responding to the feelings and thoughts of others (Dodge, 1980; Monti et al., 1986). In this context, adolescents with low levels of social cognition may develop irrational thoughts in order to cope with their repetitive failures in social relationships. It is known that tendencies such as irrational beliefs (Galassi & Galassi, 1979) negatively affect the interaction of the individual with the environment. In light of this information, it can be argued that deficiencies in social cognition would lead to irrational thinking, which will in turn be related to the problems in friendship relationships. Furthermore, it is thought that postulated mediating role of irrational beliefs between social cognition and friendship relationships will be more observable when certain elements of irrational beliefs are considered. Given that adolescents who frequently have negative experiences in their social interactions with others due to problems in their social cognition skills generally have a low self-perception (Ern & Yaacob, 2017), it is safe to say that inadequacies in social cognition may damage friendship relationships by increasing inferences that cause the individual to feel worthless (Parker et al., 2005). Therefore, it is expected that inadequacies at the level of social cognition will negatively affect friendship relationships through self-downing. Also, adolescents who have problems expressing themselves to others and cannot see things from the perspective of others, may see themselves as victims and helpless in the problems they experience in their relationships due to their negative perceptions of themselves or others (Dodge, 1980), which may increase the demand for fairness. In this respect, it is possible that increasing self-downing as a result of deficiencies in social cognition may also make the need for approval more evident (Hamarta & Demirtaş, 2009) and when this need is not satisfied due to deficiencies arising from social cognition skills and low self-esteem, a desire to get revenge could result in a highlighted sense of injustice and need to fix this situation. Similarly, those who have problems in social cognition and fail to address the underlying causes of others' behaviors within the framework of different possibilities and contexts correctly (Baron Cohen & Wheelwright, 2004), might develop a hostile and unsympathetic point of view towards the actions of others (Dodge, 1980). Such a

tendency to ignore the justifications behind the behavior of others may result in the perception of others' actions as wrongdoings and a sign of disregard for the individual (Rubin et al., 2009), which might result in other downing (Fett et al., 2011; Silverman & DiGiuseppe, 2001). In this case, social cognition is expected to affect the friendship relationships through other downings, rather than self-downing. In addition, adolescents with low social cognition act accusatory towards others and they might think that others are bad and deserve bad behaviors. Since they perceive themselves as victims, they may demand justice through other downing to diminish the feeling of victimization. The increased demand for fairness may also damage friendship relationships, where other downing and demand for fairness are expected to mediate the relationship between social cognition and friendship relationships serially.

In summary, the aim of this study is to test the mediating role of irrational beliefs between the social cognitions and friendship relationships of adolescents. For this purpose, the following hypotheses were tested:

1. Social cognition is related to both irrational beliefs and friendship relationships and irrational beliefs have a mediating role in the relationship between social cognition and friendship relationships in adolescents.
2. Self-downing has a mediating role in the relationship between social cognition and friendship relationships in adolescents.
3. The relationship between social cognition and friendship relationships is serially mediated by self-downing and demand for fairness in adolescents.
4. Other downing has a mediating role in the relationship between social cognition and friendship relationships in adolescents.
5. The relationship between social cognition and friendship relationships is serially mediated by other downing and demand for fairness in adolescents.

METHOD

Research Design

In this study, regression analysis based on bootstrap method (Hayes, 2018), which is claimed to give more reliable results than the traditional method of Baron and Kenny (1986) and the Sobel test (Hayes, 2018), was applied to measure the relationships that may occur between social cognition, friendship relationships and irrational beliefs.

Participants

Data were collected from an Anatolian high school in Aydın which has 1074 students. The sample consists of 791 students from the same school who voluntarily participated in the research. While there were 630 female students (59%) and 444 male students (41%) in the high school where the research took place, 504 female students (63.7%) and 287 male students (36.3%) participated in the research. Age of the participants ranged between 14 and 18. Of the students forming the research group, 253 (32%) were in the 9th grade, 189 were in the 10th grade (23.9%), 231 were in the 11th grade (29.2%), and 118 were in the 12th grade (14.9%).

Instruments

Tromso Social Intelligence Scale (TSIS): Since the concept of social cognition is an umbrella term that includes many processes such as perspective taking, reading emotions and social intelligence (Fergusen & Austin, 2010; Meijs et al., 2010), many different measurement tools are utilized to tap the concept such as mind reading tests, emotion discrimination tests and social intelligence tests. Also, in the literature, the concepts of social cognition and social



intelligence are sometimes used interchangeably (Brown et al., 2019). In this study, the social intelligence scale with stronger psychometric properties was preferred among the other measurement tools available in Turkish. The scale, developed by Silvera, Martinussen, and Dahl (2001), was adapted into Turkish by Doğan and Çetin (2009). Factor analysis for the validity of the study's scale revealed a similar structure obtained with the original scale, where the factor loadings of all items were above .30 and a three-factor structure was found; namely, social information processing, social awareness and social skills. Internal consistency coefficients of the whole scale is reported as .83, where the values ranged between .67 and .87 for the subscales (Doğan & Çetin, 2009). Although the scale was designed to determine the social intelligence levels of adults, it was also utilized with adolescents in previous studies and gave a similar structure (Gini, 2006; Meijs et al., 2010). In the current study, the Cronbach Alpha coefficient for the scale was .83 and the subscales' Cronbach coefficient values ranged between .73 (social awareness) and .83 (social skills).

Abbreviated General Attitude and Belief Scale (AGABS): Developed by Lindner, Kirkby, Wertheim, and Birch (1999), the scale aims to test the rational and irrational beliefs of individuals. For the confirmatory factor analysis to assess the validity of the scale, the fit values were sufficient ($\chi^2/df=1.481$, $GFI=.896$, $CFI=.956$, $RMR=.064$, $RMSEA=.043$), and factor loadings of the scale items were between 0.59 and 0.89. The scale has a seven-dimensional structure that measures irrational beliefs, including self-downing, other downing, need for achievement, need for approval, need for comfort, demand for fairness, and rationality. It consists of 26 items in total. The scale was adapted to Turkish by Urfa and Urfa (2019). While the Cronbach Alpha internal consistency coefficient scores of the scale varied between .72 (demand for fairness) and .91 (self-downing) among the sub-dimensions, the internal consistency coefficient for total irrational beliefs was .72 (Urfa & Urfa, 2019). For this study, the Cronbach Alpha coefficient for the irrational beliefs is .89. The Cronbach alfa coefficient for the subscales ranges between .69 (other downing) and .87 (self-downing).

Peer Relations Scale (PRS): Developed by Bukowski, Hoza, and Boivin (1994), the scale adapted to Turkish by Erkan Atik et al. (2014). The scale has a six-factor structure with 30 items in its original form. Later, the scale was revised and reduced to 22 items. The final form has five factors, namely; unity, conflict, help, protection and affiliation. Test-retest reliability coefficient ranged between .40 and .86. The factor loadings of 22 items varied between .37 and .81. Final confirmatory factor analysis applied to test the construct validity of 22 items confirmed the five-factor structure. The internal consistency coefficient for the whole scale was .85, while the consistency coefficient for the sub-dimensions ranged between .66 and .86. For this study, the Cronbach Alpha coefficient is .90 for the whole scale, and ranges between .73 (coexistence) and .90 (help).

Data Analysis

For data analysis, SPSS 22.0 and Process Macro 3.5 programs have been used since Process allows testing of the indirect effects of multiple mediators in a series (Van Jaarsveld, Walker and Skarlicki, 2010). Prior to the actual analysis, data was screened for the assumption of the regression analysis. There were no missing values, and the kurtosis and skewness values were in the range of ± 2.00 meaning that the normality assumption is met (Gravetter & Wallnau, 2014). The assumption of multicollinearity was met since the relationship between the predictive variables was lower than recommended value of .80 (Kalaycı, 2017), the tolerance value was greater than .10 (.86) and the VIF value was 1.16 (Çokluk, Şekercioğlu, & Büyükoztürk, 2012). Durbin Watson value, examined to test the independence of error values was in the desired range of 1-3 (1.82) (Seçer, 2017). Finally, the Mahalanobis distance checked to screen the extreme

values revealed no extreme case in the data set (Field, 2013).

After confirming that assumptions of regression analysis were met, the bootstrap technique in Process Macro with 5000 resampling option (Hayes, 2018) was used to test the postulated mediations. It was recommended that values in the 95% confidence interval (CI) obtained using bootstrap should not include the zero (0) to confirm the hypothesis (MacKinnon et al., 2004).

Descriptive Statistics, Correlation Analysis and Findings

As shown in Table 1, there is a significant positive relationship between social cognition and both friendship relationships ($r = .34, p < .01$), irrational beliefs ($r = -.37, p < .01$), sub-dimensions of other downing ($r = -.13, p < .01$), self-downing ($r = -.41, p < .01$) and demand for fairness ($r = -.12, p < .01$).

Table 1. Descriptive statistics and correlation coefficients (n:791)

Variables	1	2	3	4	5	6	x	ss	min.	max.
1 Social Cognition	1	,34**	-.37**	-.41**	-.13**	-.12**	76,78	10,74	42	105
2 Friendship Relationship		1	-.11**	-.18**	-.14**	,08*	89,29	13,04	27	110
3 Irrational Beliefs			1	,65**	,57**	,67**	65,09	14,5	22	110
4 Self-downing				1	,21**	,15**	7,18	3,73	4	20
5 Others-downing					1	,45**	9,51	2,97	3	15
6 Demand for fairness						1	16,38	3,29	4	20

Note. ** $p < .01$ * $p < .05$

The Mediating Role of Irrational Beliefs in the Relationship Between Social Cognition and Friendship Relationships

In order to test the mediating role of irrational beliefs in the relationship between social cognition and friendship relationships in adolescents, regression analysis was used through the bootstrap method based SPSS Process Macro 3.5. program, and the findings are presented in Table 2.

Table 2. Regression Analysis Results for the Mediation Test of Irrational Beliefs (n:791)

Estimate Variables	Result Variables					
	M(Irrational Beliefs)		Y(Friendship Relationship)			
	b	S.H.	b	S.H.		
X (Social Cognition)	a	-.505***	.045	c'	.424***	.044
M (Irrational Beliefs)	-	-	-	b	.021	.033
Constant	im	103,895***	3,456	iy	55,432***	4,62
		R ² = .140			R ² = .116	
		F(1; 789) = 128.490			F(2; 788) = 51.746 $p < .001$	
		$p < .001$				

Note. ** $p < .01$ * $p < .05$; Note. ** $p < .01$ * $p < .05$; b: non-standardized beta coefficients; S.E: Standard Error.

According to the results, social cognition significantly and negatively predicts irrational beliefs (a1 pathway; $b = -.505, 95\% \text{ CI} [-.5929, -.4179], t = -11.3353, p < .001$). Social cognition explains approximately 14% ($R^2 = .140$) of irrational beliefs. With the addition of irrational beliefs, the relationship between social cognition and friendship relationship is still positively significant ($b = .424, 95\% \text{ CI} [.3374, .5096], t = 9.6523, p < .001$); however, relationship between irrational beliefs and friendship relationships was not significant (b1 pathway; $b = .021, 95\% \text{ CI} [-.0432, .0843], t = .6325, p > .05$). Also, examining the confidence interval obtained from the Bootstrap technique included zero, so the total score of irrational beliefs did not mediate the relationship between social cognition and friend relationships ($b = -.010, 95\% \text{ BCA}$

CI [-.0444, .0227]). In summary, the findings do not support the first hypothesis of the study.

The Mediating Role of Self-Downing in The Relationship Between Social Cognition And Friendship Relationships

A regression analysis based on the bootstrap technique was performed to test whether self-downing belief mediates the relationship between social cognition and friendship relationships and the results are shown in Table 3.

Table 3. Results of regression analysis for the mediation test of self-downing (n: 791)

Estimate Variables	Result Variables			
	M(Self Downing)		Y(Friendship Relationship)	
	b	S.H.	b	S.H.
X (Social Cognition)	a -.142***	.011	c' .385***	.044
M (Self Downing)	-	-	b -.102	.130
Constant	im 18.071***	.875	iy 64.209***	4.15
	R ² = .167		R ² = .125	
	F(1; 789) = 157.962 p<.001		F(3; 787) = 37.477 p<.001	

Note. *p<.05, **p<.01, *** p<.001; b: non-standardized beta coefficients; S.E: Standard Error.

Social cognition predicts self-downing significantly and negatively (b= -.142, 95% CI [-.1641, -.1197], t= -12.568, p<.001). Social cognition explains about 17% (R²= .167) of self-downing. The relationship between self-downing and friendship relationships was not significant (b= -.102, 95% CI [-.3566, .1530], t= -.7841, p>.05). Social cognition and self-downing explained about 13% (R²= .125) of the variation in friendship relationships indicating they share common variance. The second hypothesis postulating self-downing mediates the relationship between social cognition and friendship relationships is not confirmed since the confidence interval (BCA CI) in the bootstrap analysis included zero (b = .0144, 95% BCA CI [-.0262, .0587]).

The Serial Mediating Role of Self-Downing and The Demand For Fairness In The Relationship Between Social Cognition and Friendship Relationships

The results of the regression analysis based on the bootstrap technique to test whether the variables of self-downing and demand for fairness serially mediate the relationship between social cognition and friendship relationships are presented in Table 4.

Table 4. Results of regression analysis of self-downing and demand for fairness serial-mediation test (n: 791)

Estimate Variables	Result Variables					
	M(S.D.)		M(D.J.)		Y(P.R.)	
	b	S.H.	b	S.H.	b	S.H.
X (Social Cognition)	a -.142***	.011	a2 -.022	.012	c' .401***	.044
M (S.D.)	-	-	d21 .108**	.034	b1 -.217	.128
M(D.J.)	-	-	-	-	b2 .511***	.134
Constant	lm1 18.071***	.88	im2 17.269***	1.04	iy	4.51
	R ² = .17		R ² = .03		R ² = .13	
	F(1; 789) = 157.962		F(2; 788) = 11.008***		F(3; 787) 40.435**	

Note. *p<.05, **p<.01, *** p<.001; b: non-standardized beta coefficients; S.E: Standard Error. S.D.: Self Downing, D.J.: Demand for fairness, P.R.: Friendship Relationship

The demand for fairness positively and significantly predicts friendships ($b = .511$, 95% BCA CI [.2489, .7732], $t = 3.8268$ $p < .001$). Demand for fairness explains 13% of friendships ($R^2 = .134$). Self-downing significantly predicts the demand for fairness (d21 way) positively ($b = .108$, 95% BCA CI [.0414, .1745], $t = 3.1846$ $p < .01$). Social cognition and self-downing explain approximately 3% ($R^2 = .027$) of the change in demand for fairness. When self-downing and demand for fairness are included in the mediation analysis together, they mediate the relationship between social cognition and friendship relations ($b = -.0078$, 95% BCA CI [-.0151, -.0053]) and that the values in the confidence interval (BCA CI) did not include zero. When the indirect effect power is examined, it is seen that there is a fully standardized effect size ($K2$) -.006. That is, self-downing and demand for fairness have a low but significant indirect effect on the relationship between social cognition and friendships, confirming third hypothesis.

The Mediating Role of Other Downing in The Relationship Between Social Cognition and Friendship Relationships

The results of the regression analysis based on the bootstrap technique to test other downing mediate the relationship between social cognition and friendship relationships are shown in Table 5.

Table 5. Regression Analysis Results for the Mediation Test of Other downing (n: 791)

Estimate Variables	Result Variables					
	M(Other Downing)			Y(Friendship Relationship)		
		b	S.H.	b	S.H.	
X (Social Cognition)	a	-.036***	.010	c'	.385***	.044
M (Other Downing)	-	-	-	b	-.392***	.150
Constant	im	12.269***	.758	iy	54.702***	4.48
		$R^2 = .017$		$R^2 = .125$		
		$F(1; 789) = 19.795$ $p < .001$		$F(3; 787) = 37.477$ $p < .001$		

Note. * $p < .05$, ** $p < .01$, *** $p < .001$; b: non-standardized beta coefficients; S.E: Standard Error.

Social cognition predicts other downing significantly and negatively ($b = -.036$, 95% CI [-.0551, -.0167], $t = -3.6742$, $p < .001$). Other downing significantly and negatively predicts friendships ($b = -.392$, 95% CI [-.6859, -.0971], $t = -2.6105$, $p < .01$). Social cognition and other downing explain approximately 13% ($R^2 = .125$) of the change in friendship relationships. The indirect effect of social cognition on friendship relationships is also significant; other downing appears to mediate the relationship between social cognition and friendship relationships ($b = .014$, 95% BCA CI [.0015, .0299]), and the values in the confidence interval (BCA CI) does not include zero. When the indirect effect power is examined, it is seen that there is a fully standardized effect size ($K2$) .012. In summary, other downing has a low but significant indirect effect on the relationship between social cognition and friendship relationships supporting the fourth hypothesis.

The Serial Mediating Role of The Other Downing And Demand For Fairness In The Relationship Between Social Cognition and Friendship Relationships

The results of the regression analysis based on the bootstrap technique to test whether other downing and demand for fairness serially mediate the relationship between social cognition and friendship relationships are shown in Table 6.

Table 6. Results of Regression Analysis of Other downing and the Demand for fairness Serial-mediation Test (n: 791)



Estimate Variables	Result Variables					
	M(D.O.)		M(D.J.)		Y(P.R.)	
	b	S.H.	b	S.H.	b	S.H.
X (Social Cognition)	a -.036***	.010	a2 -.020*	.010	c' .414***	.044
M (S.D.)	-	-	d21 .487**	.035 .805***	b1 -	.161
M(D.J.)	-	-	-	-	b2 .805***	.146
Constant	im1 12.269***	.76	im2 13.246***	.87 51.960***	iy	4.05
	R ² = .02		R ² = .21		R ² = .16	
	F(1; 789) = 13.4994***		F(2; 788) = 101.844***		F(3; 787) 48.865**	

Note. *p < .05, **p < .01, ***p < .001; b: non-standardized beta coefficients; S.E: Standard Error. D.O.: Other downing, D.J. Demand for fairness, P.R.: Friendship Relationship

The demand for fairness significantly and positively predicts friendships relationships ($b = .805$, 95% BCA CI [.5192, 1.0914], $t = 5.5254$ $p < .001$). Other downing significantly and positively predicts the demand for fairness (d21 way) ($b = .487$, 95% BCA CI [.4175, .5565], $t = 13.753$ $p < .001$). Social cognition and other downing explained approximately %21 ($R^2 = .205$) of the variation in demand for fairness. When the variables of other downing and demand for fairness are included in the mediation analysis together, they mediate the relationship between social cognition and friendship relations ($b = -.0141$, 95% BCA CI [-.0263, -.0052]) and the values in the confidence interval (BCA CI) did not include zero. When the indirect effect power is examined, it is seen that there is a fully standardized effect size ($K2$) -.012. That is, other downing and demand for fairness have a low but significant indirect effect on the relationship between social cognition and friendships relationships. These results confirm the final hypothesis.

RESULTS AND DISCUSSION

The aim of this study was to test the mediating role of irrational beliefs in the relationship between social cognition and friendship relationships. As expected, social cognition and friendship relationships were significantly and positively related and these two variables had a significant and negative relationship with irrational beliefs. In the first stage of the mediating analysis, social cognition predicted friendship relationships positively and significantly. Although there are no empirical study directly supporting the positive relationship between social cognition and friendship relationships in adolescents without aggression or bullying, studies revealing social cognition problems in aggressive adolescents (Crick & Dodge, 1994; Yoon et al., 1999) and adolescents with speech disorders (Botting & Conti-Ramsden, 2008; Forrest et al., 2022) shed some indirect support for this relationship.

Another finding of the study is the negative significant relationship between social cognition and irrational beliefs. Considering that social cognition includes the skills of perceiving the intentions and behaviors of others and regulating relations in this direction, deficiencies in these skills will result in wrongful interpretations of others' actions and unrealistic expectations. Studies showing that irrational beliefs cause difficulties in social relations as a result of inadequacies in cognitive processes (Monti et al., 1986; DiGiuseppe & Bernard, 2006; Galassi & Galassi, 1979) support this finding. Although there were no previous studies directly investigating social cognition and irrational beliefs together in the literature, studies on the relationships between social skills and irrational beliefs, which are closely related to social cognition, also indirectly support the finding of the research (Monti et al., 1986; Çivitci & Çivitci, 2009).

Although correlational analysis was in the expected direction, mediation analysis indicated that irrational beliefs

have no mediating role in the relationship between social cognition and friendship relationships. During adolescence, many variables including self-esteem (Eisenberg & Fabes 1998), altruism (Kumru et al., 2004), depression (Doğan, 2006), tendency for self-blame (Wichmann et al., 2004) along with irrational beliefs (Bester, 2014; Çivitci & Çivitci, 2009) can influence friendship relationships. Although this study did not find a relationship between irrational beliefs and the friendship relationships, some of the expected relationships were confirmed when the subcomponents were examined. In other words, the finding of this study is that the relationship between irrational beliefs and friendship relationships may vary according to different sub-dimensions of irrational beliefs. That is, not all irrational beliefs are equally detrimental for friendship. Therefore, the next section tackles this issue.

Since social cognition involves the ability to understand the messages behind the behaviors of others and to make inferences and give appropriate responses correctly, lack of social cognitive skills can lead to false beliefs about oneself and others. Assuming that this situation can be associated with self-downing in adolescents, it was expected that these irrational beliefs would harm friendship relationships. This study's results show that social cognition negatively predicts self-downing; however, self-downing does not have a mediating effect in the relationship between social cognition and friendship relations. Studies indicate that adolescents who see themselves as victims are hostile to others and withdraw because they attribute prejudices to themselves (Guy et al., 2017). This might explain the unexpected finding of the study which asserts that self-downing does not have an indirect effect on the relationship between social cognition and friendships. Only when adolescents who feel victimized because of their withdrawal (Dodge, 1980) might feel themselves entitled to get justice, which in turn might have harmful effect on the relationships.

Hamarta and Demirtaş (2009) stated that individuals who devalue themselves have a higher need for approval. In a similar vein, in the study of Addis and Bernard (2002) there is a positive relationship between the need for approval and self-downing. However, friends of adolescents who withdraw with the belief of self-downing may not have a clear idea about the failure of their relationship (Guy et al., 2017), therefore make no attempt to fix it. So, considering that in cases where this need is not met, the adolescent's unrealistic demand for fairness is expected to increase, which will further harm the friendship relations. In agreement with this expectation, the findings of this study revealed that as the social cognition levels of the adolescents decrease, self-downing beliefs increases and increasing self-downing positively affects the demand for fairness, which in turn is inversely related to the friendship relations.

In summary, this study's findings indicate that adolescents with social cognitive deficits might be more inclined to self-downing. However, this does not necessarily harm the relationships unless it raises an unrealistic sense of injustice and need to restore this situation. Future studies could look at the condition or mechanisms whereby self-downing raises the need of justice or the protective factors in spite of self-downing. This finding might also help to shed some light on the conflicting findings existing in the literature regarding whether bullies have social cognition deficiencies or not (e.g., Georgiou & Stavrinos, 2008; Kendrick et. al, 2012). That is, bullying could be a result of anger arising from irrational beliefs but not social cognition deficiencies per se. Future studies may help unravel the role of unrealistic feeling of unfairness and desire to get revenge in bullying.

Another finding of this study was the mediating role of other downing irrational beliefs in the relationship between social cognition and friendship relationships. Individuals with problems in social cognition skills cannot make appropriate inferences about situations since lack of these skills prevents individuals from defining other's feelings, thoughts and underlying meanings of the conversations accurately (Crick & Dodge, 1994). This situation not only causes adolescents to self-downing, but also to misinterpret the intentions behind the behaviors of others and display

hostile attitudes towards them (Dodge, 1980). Therefore, social cognition is expected to negatively affect friendships through other downing. Findings of this study show that other downing negatively predicts friendships and has a mediating role in the relationship between social cognition and friendship relationships. Ellis (1979) states that one of the three basic beliefs that cause irrational beliefs is "Other people should always treat me kindly, honestly, and appropriately. If they don't act like that, it's a terrible situation. Those who treat me in this way are bad and worthless people". The belief in other downing can be considered as a reflection of this belief. Adolescents with low perspective taking skills experience problems in relationships by harboring hostile feelings towards others (Fett et al., 2011). Also, adolescents who are rejected by their friends are suspicious of their friends by blaming their bad intentions for undesirable situations (Dodge, 2006; Orobio de Castro et al., 2002). Isolated and excluded adolescents may feel victimized because they cannot understand the intentions of others (Dodge, 1980). To compensate the feeling of worthlessness adolescents resent others and act accusatory and aggressive towards others, and as a result, their friendship relationships are damaged. In the light of aforementioned research, the mediating effect of other downing on the relationship between social cognition and friend relations is supported by the current literature.

When adolescents do not correctly interpret the intentions behind the behaviors of others and often display hostile references, they see themselves as victims and experience problems in their relationships (Dodge, 1980). Adolescents who feel treated unfairly might harbor hostility towards others, which leads to increasing level of injustice. This expectation is confirmed by the current study's findings that social cognition and other downing predicted the demand for fairness positively, and that these variables had negative effects on friendship relationships.

CONCLUSION AND RECOMMENDATIONS

The present study shows that in the relationship between social cognition and friendship relationships in adolescents, other downing directly mediates while the demand for fairness mediates both self-downing and other downing. These results suggest that lack of social cognition skills harm friendship relationships by preventing adolescents to consider the right reasons behind others' behaviors leading hostile perception of themselves and others, which in turn increases the unhealthy behaviors of demand for fairness. This study extends the current literature by showing the mechanisms whereby lack of social cognition skills negatively affect friendship relationships of adolescents; namely, inducing irrational beliefs of other downing and demand for fairness. These findings raise the importance of implementation of rational emotional and behavioral psychoeducation programs to replace irrational beliefs with rational beliefs and to improve social cognitive ones.

This study has some limitations and implications for future research. This study is a correlational study with no longitudinal or experimental data, which hinders drawing conclusions based on cause-effect. Future studies with experimental and longitudinal data could help shed light on the topic better. Since the research was carried out in an Anatolian high school in Aydın, new studies can be conducted with different participants such as in different developmental stages and from different socioeconomic conditions. Additionally, this research consists of only quantitative methods. Qualitative studies can be conducted to determine what causes the problems experienced by adolescents with low social cognition skills resulting failure in friendships.

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REFERENCES

- Addis, J., & Bernard, E. M. (2002). Marital adjustment and irrational beliefs. *Journal of Rational-Emotive and Cognitive-Behavior Therapy*, 20(1), 3-13. <https://doi.org/10.1023/A:1015199803099>
- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182. <https://doi.org/10.1037/0022-3514.51.6.1173>
- Baron Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism and normal sex differences. *Journal of Autism and Developmental disorders*, 34(2), 163-175. <https://doi.org/10.1023/B:JADD.0000022607.19833.00>
- Bernard, M.E. (1990). Rational-emotive therapy with children and adolescents: Treatment strategies. *School Psychology Review*, 19(3), 294-303. <https://doi.org/10.1080/02796015.1990.12085468>
- Bester, G. (2014). Irratioanl beliefs of adolescents who experience group pressure. *Tydskrift vir Geesteswetenskappe*, 54(2), 304-323.
- Blakemore, S. J., & Choudhury, S. J. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Child Psychology and Psychiatry*, 47, 296-312. <https://doi.org/10.1111/j.1469-7610.2006.01611.x>
- Bosma, H.A., & Koops, W. (2005). Social cognition in adolescence: A tribute to Sandy (A.E.) Jackson (1937-2003). *European Journal of Developmental Psychology*, 1(4), 281-288. <https://doi.org/10.1080/17405620444000256>
- Botting, N., & Conti-Ramsden, G. (2008). The role of language, social cognition, and social skill in the functional social outcomes of young adolescents with and without a history of SLI. *British Journal of Developmental Psychology*, 26(2), 281–300. <https://doi.org/doi:10.1348/026151007X235891>
- Brown, M.I., Rajatska, A., Hughes, S.L., Fishman, J.B., Huerta, E., & Chabris, C.F. (2019). The social shapes test: A new measure of social intelligence, mentalizing, and theory of mind. *Personality and Individual Differences*, 143, 107-117. <https://doi.org/10.1016/j.paid.2019.01.035>
- Bukowski, W. M., Hoza, B., & Boivin, M. (1994). Measuring friendship quality during pre- and early adolescence: The development and psychometric properties of the Friendship Qualities Scale. *Journal of Social and Personal Relationships*, 11(3), 471–484. <https://doi.org/10.1177/0265407594113011>
- Ciarrochi, J. (2004). Relationship between dysfunctional beliefs and positive and negative indices of well-being: A critical evaluation of the common beliefs survey-III. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, 22, 171-188. <https://doi.org/10.1023/B:JORE.0000047306.55720.4e>
- Crick, N. R., & Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological Bulletin*, 15(1), 74–101. <https://doi.org/10.1037/0033-2909.115.1.74>
- Çivitci, A. (2007). Erken ergenlik döneminde içsel-dışsal denetim odağı boyutları ve cinsiyete göre mantıkdışı inançlar. *Çocuk ve Gençlik Ruh Sağlığı Dergisi*, 14(1), 3-12.
- Çivitci, A. & Çivitci, N. (2009). İlköğretim öğrencilerinde algılanan sosyal beceri ve mantıkdışı inançlar. *Elementary Education Online*, 8(2), 415-424.
- Çivitci, A. ve Topbaşoğlu, T. (2015). Akılcı duygusal eğitimin ortaokul öğrencilerinin yaşam doyumu üzerindeki etkisi. *Ege Eğitim Dergisi*, 1(16), 13-29. <https://doi.org/10.12984/eed.56560>
- Çokluk, Ö., Şekercioğlu, G. & Büyükoztürk, Ş. (2012). Sosyal bilimler için çok değişkenli istatistik: SPSS ve LISREL uygulamaları. Pegem Akademi.
- Desatnik, A., Bel-bahar, T., Taylor, L., Nolte, T., Crowley, M.J., Fonagy, P., & Fearon, P. (2020). Emotion regulation in adolescents: Influences of internal representations of relationships – An ERP study. *International Journal of*

- Psychophysiology, 160(3), 1-9. <https://doi.org/10.1016/j.ijpsycho.2020.11.010>
- DiGiuseppe, R., & Bernard, M.E. (2006). REBT Assessment and treatment with children. In A. Ellis and M. E. Bernard (Eds.), *Rational emotive behavioral approaches to childhood disorders: Theory, practice and research* (1.st ed., pp. 85-114). Springer.
- Dodge K. (1980). Social cognition and children's aggressive behavior. *Child Development*, 51(1), 162-170. <https://doi.org/10.2307/1129603>
- Dodge, K. A. (2006). Translational science in action: Hostile attributional style and the development of aggressive behavior problems. *Development and Psychopathology*, 18(3), 791-814. <https://doi.org/10.1017/S0954579406060391>
- Doğan, T. (2006). Üniversite öğrencilerinin sosyal zeka düzeylerinin depresyon ve bazı değişkenlerle ilişkisinin incelenmesi (Yayınlanmamış yüksek lisans tezi). Sakarya Üniveristesi Sosyal Bilimler Enstitüsü.
- Doğan, T., & Çetin, B. (2009). Tromso Sosyal Zekâ Ölçeği Türkçe formunun faktör yapısı, geçerlik ve güvenilirlik çalışması. *Educational Sciences: Theory and Practice*, 7(1), 241-268.
- Eisenberg, N., & Fabes, R. A. (1998). Prosocial development. W. Damon and N. Eisenberg (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (5th ed., pp. 701-778). John Wiley & Sons.
- Ellis, A. (1979). Rational-emotive therapy. A. Ellis & J. M. Whiteley (Eds.), *Theoretical and empirical foundations of rational-emotive therapy* (pp.1-6). Brooks/Cole Publishing Company.
- Ellis, A. (1993). Reflections on rational-emotive therapy. *Journal of Consulting and Clinical Psychology*, 61(2), 199-201. <https://doi.org/10.1037/0022-006X.61.2.199>
- Erkan Atik, Z., Çok, F., Esen Çoban, A., Doğan, T. ve Güney Karaman, N. (2014). Akran ilişkileri ölçeği'nin Türkçeye uyarlanması: Geçerlik ve güvenilirlik çalışması. *Kuram ve Uygulamada Eğitim Bilimleri*, 14(2), 433-446. doi:10.12738/estp.2014.2.1778
- Ern, S. T., & Yaacob. N. R. N. (2017). Disputing irrational beliefs technique to develop female adolescent self-esteem. *Social Sciences & Humanities*, 25(S), 181-192.
- Ferguson, F.J., & Austin, E.J. (2010). Associations of trait and ability emotional intelligence with performance on theory of mind tasks in an adult sample. *Personality and Individual Differences*, 49(5), 414-418. <https://doi.org/10.1016/j.paid.2010.04.009>
- Fett, A.K.J., Viechtbauer, W., Dominguez, M. de G., Penn, D.L., van Os, J., & Krabbendam, L. (2011). The relationship between neurocognition and social cognition with functional outcomes in schizophrenia: A meta-analysis. *Neuroscience and Biobehavioral Reviews*, 35(3), 573-588. doi:10.1016/j.neubiorev.2010.07.001
- Fett, A. K. J., Shergill, S. S., Gromann, P. M., Dumontheil, I., Blakemore, S. J., Yakub, F., & Krabbendam, L. (2014). Trust and social reciprocity in adolescence : A matter of perspective taking. *Journal of adolescence*, 37(2), 175-184. <https://doi.org/10.1016/j.adolescence.2013.11.011>
- Field, A. (2013). *Discovering statistics using spss* (4th ed.). Sage Publication
- Forrest, C.L., Lloyd-Esenkaya, V., Gibson, J.L., & Clair, M.C. (2022). Social cognition in adolescents with developmental language disorder (DLD): Evidence from the social attribution task. *Journal of Autism and Developmental Disorders*. <https://doi.org/10.1007/s10803-022-05698-6> (in press)
- Galassi, J.P., & Galassi, M.D. (1979). Modification of heterosocial skills deficits. A.S. Bellack and M. Hersen (Eds.), *Research and practice in social skills training* (1st ed., pp. 131-188). Springer.
- Georgiou, S. N., & Stavrinides, P. (2008). Bullies, victims and bully-victims: Psychosocial profiles and attribution styles. *School Psychology International*, 29(5), 574-589. <https://doi.org/10.1177/0143034308099202>
- Gilman, R., & Huebner, E. S. (2006). Characteristics of adolescents who report very high life satisfaction. *Journal of Youth and*

- Adolescence, 35, 293-301. <https://doi.org/10.1007/s10964-006-9036-7>
- Gini, G. (2006). Social cognition and moral cognition in bullying: What's wrong? *Aggressive Behavior*, 32(6), 528-539. doi: <https://doi.org/10.1002/ab.20153>
- Gravetter, F., & Wallnau, L. (2014). *Essentials of statistics for the behavioral sciences*. Cengage: Wadsworth.
- Green, M.F., Penn, D.L., Bentall, R., Carpenter, W.T., Gaebel, W., Gur, R.C., ... Heinsen, R. (2008). Social cognition in schizophrenia: An NIMH workshop on definitions, assessment, and research opportunities. *Schizophrenia Bulletin*, 34(6), 1211-1220. <https://doi.org/10.1093/schbul/sbm145>
- Guy, A., Lee, K., & Wolke, D. (2017). Differences in the early stages of social information processing for adolescents involved in bullying. *Aggressive Behaviour*, 43(6), 578-587. <https://doi.org/10.1002/ab.21716>
- Hamarta, E. & Demirtaş, E. (2009). Lise öğrencilerinin utangaçlık ve benlik saygılarının fonksiyonel olmayan tutumlar açısından incelenmesi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 21, 239-247.
- Hayes, A.F. (2018). *Introduction to mediation, moderation and conditional process analysis: A regression-based approach*. Guilford Press.
- Kalaycı, Ş. (Ed.). (2017). *Spss uygulamalı çok değişkenli istatistik teknikleri* (8.baskı). Dinamik Akademi.
- Kendrick, K., Jutengren, G., & Stattin, H. (2012). The protective role of supportive friends against bullying perpetration and victimization. *Journal of Adolescence*, 35, 1069-1080. <https://doi.org/10.1016/j.adolescence.2012.02.014>
- Kıran Esen, B., & Gündoğdu, M. (2010). The relationship between internet addiction, peer pressure and perceived social support among adolescents. *The International Journal of Educational Researchers*, 2(1), 29-36.
- Kilford, E. J., Garrett, E., & Blakemore, S. J. (2016). The development of social cognition in adolescence: An integrated perspective. *Neuroscience and Biobehavioral Reviews*, 70, 106-120. <https://doi.org/10.1016/j.neubiorev.2016.08.016>
- Kumru, A., Carlo, G., & Edwards, C. P. (2004). Olumlu sosyal davranışların ilişkisel, kültürel, bilişsel ve duyuşsal bazı değişkenlerle ilişkisi. *Türk Psikoloji Dergisi*, 54, 109-125.
- Lindner, H., Kirkby, R., Wertheim, E., & Birch, P. (1999). A brief assessment of irrational thinking: The shortened general attitude and belief scale. *Cognitive Therapy and Research*, 23(6), 651-663. <https://doi.org/10.1023/A:1018741009293>
- Mackinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, 39(1), 99-128. https://doi.org/10.1207/s15327906mbr3901_4
- Mayer, J.D., Caruso, D., & Salovey, P. (1999). Emotional intelligence meets traditional standards for an intelligence. *Intelligence*, 27(4), 267-298. . [https://doi.org/10.1016/S0160-2896\(99\)00016-1](https://doi.org/10.1016/S0160-2896(99)00016-1)
- Meijs, N., Cillesen, A. H. N., Scholte, R.H.J., Segers, E., & Spijkerman, R. (2010). Social intelligence and academic achievement as predictors of adolescent popularity. *Journal Youth Adolescence*, 39, 62-72. <https://doi.org/10.1007/s10964-008-9373-9>
- Monti, P.M., Zwick, W.R., & Warzak, W.J. (1986). Social skills and irrational beliefs: A preliminary report. *Journal of Behavior Therapy and Experimental Psychiatry*, 17(1), 11-14. [https://doi.org/10.1016/0005-7916\(86\)90004-2](https://doi.org/10.1016/0005-7916(86)90004-2)
- Orobio de Castro, B., Veerman, J.W., Koops, W. Bosch, J.D., & Monshouwer, H.J. (2002). Hostile attribution of intent and aggressive behavior: a meta-analysis. *Child Development*, 73(3), 916-934. <https://doi.org/10.1111/1467-8624.00447>
- Parker, J. G., Low, C., Walker, A. W., & Gamm, B. K. (2005). Children's friendship jealousy: Assessment of individual differences and links to gender, self-esteem, aggression, and social adjustment. *Developmental Psychology*, 41(1), 235-250. <https://doi.org/10.1037/0012-1649.41.1.235>
- Rubin, K.H., Bukowski, W. M., Parker, J.G., & Bowker, J.C. (2008). Peer interactions, relationships and groups. W. Damon and

- R.M. Lerner (Eds.), *Child and adolescent development: An advanced course* (1st ed., pp. 141-171). John Willey ve Sons.
- Rubin, K.H., Coplan, R.J., & Bowker, J.C. (2009). Social withdrawal in childhood. *Annual Review of Psychology*, 60(1), 141-171. <https://doi.org/10.1146/annurev.psych.60.110707.163642>
- Seçer, İ. (2017). *Spss ve lisrel ile pratik veri analizi analiz ve raporlaştırma* (3. baskı). Anı Yayıncılık.
- Short, R. J., & Simeonsson, R. J. (1986). Social cognition and aggression in delinquent adolescent males. *Adolescence*, 21(81), 159-176.
- Silverman, S., & DiGiuseppe, R. (2001). Cognitive-behavioral constructs and children's behavioral and emotional problems. *Journal of Rational-Emotive and Cognitive Behavior Therapy*, 2(19), 119-134. <https://doi.org/10.1023/A:1011183506003>
- Silvera, D. H., Martinussen, M., & Dahl, T. I. (2001). The Tromso Social Intelligence Scale, a self-report measure of social intelligence. *Scandinavian Journal of Psychology*, 42(4), 313-319. <https://doi.org/10.1111/1467-9450.00242>
- Singer, T., & Lamm, C. (2009). The social neuroscience of empathy. *Annals of the New York Academy of Sciences*, 1156(1), 81-96. <https://doi.org/10.5167/uzh-25655>
- Urfa, O. & Urfa, D. T. (2019). Kısaltılmış Genel Tutum ve İnanç Ölçeği'nin Türkçeye uyarlanması. *Uluslararası Türk Eğitim Bilimleri Dergisi*, (12), 53-61.
- van Jaarsveld, D. D., Walker, D. D., & Skarlicki, D. P. (2010). The role of job demands and emotional exhaustion in the relationship between customer and employee incivility. *Journal of Management*, 36(6), 1486-1504. <https://doi.org/10.1177/0149206310368998>
- Wichmann, C., Coplan, R. J., & Daniels, T. (2004). The social cognitions of socially withdrawn children. *Social Development*, 13(3), 377-392. <https://doi.org/10.1111/j.1467-9507.2004.00273.x>
- Yoon, J., Hughes, J., Gaur, A., & Thompson, B. (1999). Social cognition in aggressive children: A metaanalytic review. *Cognitive and Behavioral Practice*, 6(4), 320-331. [https://doi.org/10.1016/S1077-7229\(99\)80051-0](https://doi.org/10.1016/S1077-7229(99)80051-0)