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TITLE: Accumulation of Stressors as a Predictor of Depression Amongst Early to Middle Adolescence

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Abstract

Background: Depression rapidly increases during adolescence, particularly for girls. One theory to explain this gender difference is the accumulation theory which suggests that girls face different, and in part more, risk factors that co-occur with adolescence compared to boys. The accumulation was tested against the alternative theory which suggests that girls and boys have similar risk factors, but girls value you them more negatively than boys. **Methods:** The study was made up of four waves, with approximately nine months between each wave, whereby predictors from various domains were investigated. The Children's Depression Inventory (CDI) was administered to a large school population ($n = 406$) at all waves. At wave one participants were aged 11-15 years. Perceived rejection was measured using schematic faces, while pubertal timing, school transition and negative life events were examined with a self-report questionnaire. Negative life events included divorce, sickness of self, sickness of a close family member and psychological complaints. **Results:** Perceived rejection and psychological complaints significantly predicted adolescent depression. Additionally, girls perceived more rejection and reported more psychological complaints compared to boys. Psychological complaints were age specific. Multiple co-occurring risk factors did not strengthen each other's negative effects. As such, there is reason to believe that part A of the accumulation theory explains gender difference in adolescent depression. **Conclusions:** Overall, this study provided new insight into cumulative effects in the course of early life depression. The gender difference in adolescent depression is partly explained by the fact that girls tend to experience more co-occurring challenged during this period compared to their male counterparts.

Keywords: adolescence; adolescent depression; accumulation; pubertal timing; perceived rejection; negative life events

Introduction

Adolescents are confronted with several developmental challenges and disruptions in which both their biological and psychosocial functioning go through considerable changes in order to prepare for life as an adult (Psychology Today, 2019; DiMaria, 2018; Cicchetti & Rogosch, 2002). As such, this crucial developmental period is associated with heightened risk for psychopathology (Hayward, 2003; Hayward & Sanborn, 2002; Zahn-Waxler, Shirtcliff & Marceau, 2008; Graber, 2013; Mendle & Ferrero, 2012; Negri & Susman, 2011; Reardon, Leen-Felder & Hayward, 2009).

The proportion of depression tends to be equal in boys and girls prior to adolescence (Marcotte, Fortin, Potvin & Papillon, 2002; Maughan, Collishaw & Stringaris, 2013; Rutter, 1986; Brooks-Gunn, 1991; Nolen-Hoeksema, 1990). However, by middle adolescence the presence of depression among girls is overpowering (Thaper, Collishaw, Pine & Thaper, 2012; Maughan et al., 2013; Avenevoli, Swendsen, He, Bustin, & Merikangas, 2015; Mendle, Harden, Brookes-Gunn & Graber, 2010). It appears this trend persists into adulthood (Sim, Lau, Sim, Sum & Baldessarini, 2015; Harkness, Alavi, Monroe, Slavich, Gotlib & Bagby, 2010; Pettit, Hartley, Lewinsohn, Seeley & Klein, 2013; Sheeber, Hops, Davis & 2001), indicating that this problem is not temporary. It is, therefore, necessary to prevent the first occurrence of depression by understanding where it comes from, in order to lower the high relapse rate (Burcusa & Iacono, 2007; Sim et al., 2015).

It is clear that at some point during adolescence development goes awry which results in an exponential increase in depression, particularly among adolescent girls. This begs the question why does depression increase more so in girls than in boys, particularly during adolescence? There are two main explanations for the gender difference in depression during adolescence. Either, girls have more, and in part different, risk factors from boys (Turner,

Wheaton & Lloyd 1995; Turner & Lloyd 1999; McLeod & Kessler 1990; Turner & Avison 2003; Hankin & Abramson, 2001; Ge, Lorenz, Conger, Elder, & Simons, 1994; Hankin, Mermelstein, & Roesch, 2007; Rudolph, Hammen, Burge, Lindberg, Herzberg & Daley, 2000) or alternatively girls have similar risk factors as boys but they value these risk factors more negatively compared to boys (here termed alternative theory; Aneshensel, Rutter, & Lachenbruch, 1991; Hagan & Foster 2003; Harkness et al., 2010; Shih, Eberhart, Hammen, & Brennan, 2006; Adkins et al., 2009).

A variant of the first explanation, known as the accumulation theory, will be investigated in this study. The accumulation theory states that it is not necessarily important which risk factors are present, but rather how a number of risk factors might co-occur, interact with and strengthen one another that is of importance (Kerig, Ludlow, & Wenar, 2012). The accumulation theory is very broad, therefore two specific parts of this theory will be investigated. Part A investigates whether a number of risk challenges co-occur with adolescence, which makes this phase even more challenging, and ultimately heightening the individual's risk for depression (Dubas & van Beek, in preparation; Silberg et al., 1999; Ge, Natsuaki, & Conger, 2006). In general, multiple risk factors have a cumulative effect (Kerig, Ludlow, & Wenar, 2012), however, there is limited knowledge whether this is true for depression in adolescence. It appears that due to the timing of sexual maturation occurring approximately one and a half years earlier in girls than in boys (Louw & Louw, 2014), girls are faced with multiple risk factors that tend co-occur with this already challenging period. Thus, individuals who experience an accumulation of risk factors during adolescence may have additionally strained coping resources, and ultimately are more likely to develop depression (Dubas & van Beek, in preparation; Silberg et al., 1999; Ge, Natsuaki, & Conger, 2006).

Part B explores whether multiple risk factors co-occur and interact with one another. As risk factors co-occur with one another they may strengthen each other's negative effect and further increase the likelihood of developing depression (Kendler, Gardner, & Prescott, 2002; Dubas & van Beek, in preparation). Therefore, can the accumulation theory accurately explain why depression is significantly more common in female adolescents than their male counterparts?

This study will focus on three risk factors that tend to accumulate in early adolescence when trying to answer the two main research questions: (1) do girls have more challenges that co-occur with adolescence than boys (hypothesis A); and (2) do multiple risk factors strengthen each other's negative effects (hypothesis B). Additionally, it will investigate whether the alternative theory, that girls simply value these challenges as more negative, is true by studying possible interactions with gender (hypothesis C). The study will investigate the effects of risk factors from several developmental domains such as the social domain (rejection sensitivity) and physiological domain (pubertal timing) as well as normal (school transition) and problematic (negative life events) environmental changes. As such, the factors examined include pubertal timing co-occurring with the transition to middle school, perceived rejection, and various negative life events.

Pubertal Timing Co-Occurring with School Transition

A major challenge faced during adolescence is sexual maturation. Sexual maturation, generally known as puberty, starts when the primary sex characteristics begin to develop (Ge et al., 2001; Graber & Brooks-Gunn, 1996). Simultaneously, secondary sex characteristics start to mature and rapid growth occurs (Rogol, Roemmich, & Clark, 2002). Menstruation tends to be the most indicative sign of puberty in girls, while for boys it is the first discharge of semen. The average onset age of menstruation in Europe is between 11 and 13 years old

(Moss, 2015), which is 18 months earlier than sexual maturation in boys (Louw & Louw, 2014; Chumlea et al., 2003; Graber, 2013; Mendel, 2014b). Puberty is an extremely chaotic event (Louw & Louw, 2014), and has been identified as a notable predictor of psychopathology during adolescence (Graber, 2013; Beltz et al., 2014; Mendel, 2014; Ge & Natsuaki, 2009).

In the Netherlands, all students move to secondary school after the sixth year of primary education (group eight). As such, students are around 12 years old during this shift. This transition can be taxing on individuals as it results in a change in the school environment, disturbs important friendships, and interferes with school performance (Psychology Today, 2019; Coley & Kull, 2019). Consequently, school change alone can be considered stressful for an adolescent. However, in girls, pubertal timing occurs more often in the same period as the progression to secondary school, (herein referred to as the “double transition”), making this additionally stressful (Marcotte et al., 2002; Dubas & van Beek, in preparation). Among boys, the double transition is rarely experienced as it only occurs for those who develop significantly earlier or for those who have been held back in school at earlier ages (Petersen, Sarigiani, & Kennedy, 1991; Dubas & van Beek, in preparation). Thus, girls do face more challenges that occur during adolescence compared to boys.

The first study to examine this double transition was an American study, which suggests that it is related to depressive symptoms in adolescent girls but not boys, as it is uncommon (Petersen, Sarigiani, & Kennedy, 1991). The second study was a Dutch study replicated by Dubas and van Beek (in preparation), which used data from a nationally representative sample of Dutch adolescents. Despite this, the depression measure used in this study was not optimal. Thus, another replication is necessary whereby depression is measured consistently and accurately. Based on the literature it is hypothesised that the

double transition will significantly predict adolescent depression, and will be experienced significantly more often in girls.

Perceived Rejection

Another co-occurring challenge with both maturation and school change is the development of meaningful relationships with peers. Individuals develop a greater need for closeness and self-disclosure during adolescence, as well as an intense desire to ‘belong’ (Louw & Louw, 2014). During adolescence peers contribute greatly to the individual’s identity development (Graber, 2013) and close friendships assist in coping with the developmental stressors such as physical development, school transition and instilling feelings that the individual belongs (Louw & Louw, 2014), as well as offsetting loneliness and isolation (Ge et al., 2001; York, 2007). Adolescents’ social development is, therefore, distinguished by an increasing interest in and involvement with their peer group, in which friendships are, to a greater extent based on emotional connection, trust, and acceptance (Louw & Louw, 2014; McDonald, Bowker, Rubin, Laursen, & Duchene, 2010; Brown & Larson, 2009; Graber, 2013).

Consequently, if the creating of meaningful relationships is not successful, particularly during adolescence, individuals may be more sensitive to rejection. Adolescents hypersensitive to rejection may respond with heightened negativity to apparent nastiness and may even be adversely affected by peer experiences that are even slightly challenging (Chango, McElhaney, Allen, Schad, & Marston, 2012; Berndt, 1982). Perceived rejection is known to be a risk factor for depression (Downey et al, 1998; Boivin, Hymel, & Bukowski, 1995; Nolan, Flynn, & Garber, 2003; Panak & Garber 1992; Graber, 2013; Kupersmidt & Patterson, 1991).

Furthermore, it may be that as girls sexually mature relatively earlier than boys, physical differences between the two genders become more apparent (Louw & Louw, 2014; Conley & Rudolph, 2009; Fraser-Thill, 2019). As a result, girls become more uncertain, not only of themselves but also of their relationships (Graber, 2013; Hankin & Abela, 2005; Williams & Currie, 2000) which negatively affects identity development and self-esteem (Fraser-Thill, 2019). As girls' are confronted with several co-occurring challenges, their resources are taxed resulting in a heightened sensitivity towards rejection. As such, this could explain why girls may be at an increased risk for developing depression (hypothesis A). Therefore, heightened sensitivity to rejection may strengthen the risk for the development of depression and is a risk factor of itself, but it also tends to be stimulated by earlier maturation.

Alternatively, it may be that the heightened sensitivity towards rejection has a more profound effect on the well-being of girls. This is because the increased importance placed on peer relationships in adolescence is particularly noticeable in girls, who have strong inclinations towards interpersonal caring, tend to display an increased desire for social acceptance, and exaggerated worries about peer appraisals (Rose & Rudolph, 2006; Buhrmester, 1998; Pickett, Gardner, & Knowles, 2004; Natsuaki et al., 2009). This supports the alternative hypothesis (hypothesis C) indicating that girls and boys value challenges differently.

Negative Life Events

In addition to the stress involved with pubertal development and school change, as well as perceived rejection, stress from other negative life events adds yet another challenge to this already challenging period. Many events are minor and exert relatively little impact on the individual's life (Compas, 1987); however, some events are major and involve dramatic levels of change and upheaval, regardless of the individual's age or gender. These major

negative life events may include parental divorce, the loss of a loved one, mental illness or migration. It is known that negative life events such as divorce (Hill, 1993; Cherlin, Chase-Lansdale, & McRae, 1998; Fridrik, Jónsson, Njardvik, Ólafsdóttir, & Grétarsson, 2000; Ge, Natsuaki, & Conger, 2006), psychological problems (Marum, Clench-Aas, Nes & Raanaas, 2014; Homlong, Rosvold, Sagatun, Wentzel-Larsen, & Haavet, 2015) and serious illness (Burr, Good, & Good, 1983; Golics, Basra, Finlay, & Salek, 2013) are common predictors of depression and have serious long-term health effects (Harkness et al., 2010; Silberg et al., 1999; DuBois, Felner, Brand, Adan, & Evans, 1992; Lewinsohn, Roberts, Seeley, Rhode, Gotlib, & Hops, 1994). For example, a study conducted by Friedman (2011) determined that parental divorce during childhood was the single strongest social predictor of early death. Based on existing literature it is hypothesised that any negative life event will significantly predict adolescent depression.

However, what is not known is whether the accumulation of such life events and other challenges associated with adolescence results in stronger negative effects. The abovementioned negative life events are often accompanied by a lack of social and parental support, which may place further strain on the adolescent's coping resources and leave them at greater risk for developing depression. Some studies find adolescent girls report major negative life events more often than their male counterparts (Ge, Natsuaki, & Conger, 2006; Flook, 2011; Rudolph et al., 2000), however, it is not found in all studies (Adkins et al., 2009). A possible reason is that the co-occurring of multiple stressors will overburden girls' coping resources more so than boys, leaving them at a greater risk for developing depression (Hyde et al., 2008; Graber, 2013). This explanation supports the accumulation theory (hypothesis B) indicating that when negative life events, co-occur with the challenges associated with adolescence they tend to have an even stronger effect on well-being, than when they do not co-occur with such challenges. Moreover, this study aims to investigate

whether the accumulation of major negative life events which co-occur with the challenges that already accompany adolescence such as puberty, school transition and perceived rejection, predicts depression. It is anticipated that each and every negative life event will significantly predict depression, more so in girls than in boys affect as they already have additional challenges to deal with.

This Study

The aim of the study is to predict the highest depression score over four waves. Although it is clear that at this age range there are direct effects of each risk factor in predicting depression, there is limited accumulation literature regarding adolescent depression in trying to explain the gender difference. This study will investigate whether this difference exists because girls have more and/or, in part, different risk factors than boys (accumulation theory part A; Turner, Wheaton & Lloyd 1995; Turner & Lloyd 1999; McLeod & Kessler 1990; Turner & Avison 2003; Hankin & Abramson, 2001; Ge, Lorenz, Conger, Elder, & Simons, 1994; Hankin, Mermelstein, & Roesch, 2007; Rudolph, Hammen, Burge, Lindberg, Herzberg & Daley, 2000) or alternatively because girls have similar risk factors as boys but they value these risk factors more negatively compared to boys (alternative theory; Aneshensel, Rutter, & Lachenbruch, 1991; Hagan & Foster 2003; Harkness, et al., 2010; Shih, Eberhart, Hammen, & Brennan, 2006; Adkins et al., 2009). If the accumulation theory is true then it is hypothesised that challenges which co-occur will result in their negative effects being strengthened (accumulation theory part B), which will explain additional variance in adolescent depression, and will occur more often in girls.

Pubertal timing, school transition, perceived rejection, and negative life events occur during adolescence, making this challenging period additionally stressful. In particular, it is hypothesised that adolescence is more strongly associated with depression in the context of

several co-occurring challenges, and this cumulative effect would be more significant in girls compared to boys (hypothesis A). Furthermore, the cumulative nature of multiple stressors during this relatively short period of time leaves the adolescent overwhelmed and less able to respond to additional challenges such as school change or negative life events (Dubas & van Beek, in preparation; Compas, 1987; Turner & Turner, 1999; McDonald et al., 2010; Tausig, 1982). As such, these negative effects are strengthened when challenges co-occur with one another (hypothesis B) and result in a greater risk for developing depression.

Method

Participants

Participants were selected from a larger sample ($N = 606$) if they were not yet mildly depressed ($CDI < 13$) at wave 1. See van Beek and Dubas (2008) for a more detailed description of how the participants in the larger sample were selected and recruited.

Participants were recruited from two Dutch secondary schools and were mainly HAVO and VWO students, although there were some VMBO learners. Data were collected in four waves, which were on average nine months apart. The final study sample consisted of 406 participants, of which 217 (53.40%) were girls ($M_{age\ at\ wave\ 1} = 14.51$ years; $SD = 1.03$) and 189 (46.60%) were boys ($M_{age\ at\ wave\ 1} = 14.61$ years, $SD = 1.05$).

Measures

Adolescent Depression.

Depressive symptoms were measured at wave one to four using the Dutch version (van Beek, Hessen, Hutteman, Verhulp, & van Leuven, 2012) of the Children's Depression Inventory (CDI). This self-report questionnaire consisted of 28 items whereby participants' indicated which description best applied to them out of 3 options which were coded as $0 = not\ depressed$, $1 = slightly\ depressed$, and $2 = clearly\ depressed$. Scores across all items were summed and used in the present study as a measure of overall depressive symptoms. The

highest CDI score for each participant over the four waves was selected as the outcome variable. Using the highest depression score is a better measure than using the mean of the four depression scores as depression is episodic (Sheeber, Hops & Davis, 2001). As the CDI scores were not normally distributed, a log transformation was used to correct for this. Once the transformation was done all assumptions were met. All analyses that were conducted made use of the transformed data. The reliability of the Dutch version of the CDI was good (Cronbach's $\alpha = .81$, van Beek et al., 2012).

Pubertal Timing.

Pubertal timing was based on a self-report measure, which asked the participant's age at which peak height velocity (growth spurt) was reached. This information was assessed at wave four to ensure all participants would have gone through this transformation. The age of peak height velocity has been found to be a reliable measure of pubertal timing for both boys and girls (Berenbaum, Bletz, & Corley, 2015; Petersen, Sarigiani, & Kennedy, 1991). Additionally, the self-report investigated the age at which menarche occurred for girls as it is considered an important psychological event (Natsuaki, Leve, & Mendle, 2011) as well as the age at which boys' voices broke. These measures were selected as they are good indicators of pubertal timing (Ullsperger & Nikolas, 2017; Joinson et al., 2013; Cui et al., 2012). However, the age of peak height velocity was used in this study in order to have equivalent measures across genders.

Pubertal Timing Co-occurring with School Transition.

School transition in the Netherlands is known to take place around the age of 12 years. A dichotomous (yes/no) variable was created by examining whether the adolescent experienced his or her growth spurt within one year of changing from primary school to secondary school. This variable was referred to as the double transition.

Perceived Rejection.

To measure perceived rejection, participants were presented with 24 schematic drawings of faces (Figure 1, see Appendix A page 45) known to vary in intensity and ambiguity. See van Beek and Dubas, (2008) for a more detailed description of the instrument. The present study included gendered faces and additional low intensity faces. In reality, adolescents increasingly regulate their negative facial expressions by suppressing them or hiding them behind a smile. The results are low intensity and ambiguous faces. Thus, the inclusion of additional lower intensity and ambiguous faces is highly necessary as adolescents regularly need to interpret these faces. Individual differences come from whether an individual suspects "true" emotions to be more negative than in reality.

As each face was shown, participants were asked to imagine being in a conversation with the person in the drawing and to indicate the extent to which they think the person in the picture likes talking to him or her. With this, the rejection was measured. Scores ranged from $-3 = \text{disliked very much}$ to $3 = \text{liked very much}$, with more negative scores indicating that the face was perceived as more rejecting. In this study, only whether the person perceived rejection was of importance, which is referred to as "perceived rejection" for the remainder of this study. The gender specific means were inputted for perceived rejection if data were missing. The reliability of the schematic drawings was good (Cronbach's $\alpha = .78$). The relatively high Cronbach's alpha indicates that if participants tend to perceive more rejection they tend to do that for all types of faces.

Negative Life Events.

To assess the different negative life events, a questionnaire was completed by each participant at each wave, asking if they had experienced certain life events and the age they were when these life events occurred. The negative life events important for this study

included parental divorce, serious illness of oneself, serious illness of a close family member (parents or siblings) and any psychological complaints. Psychological complaints from oneself ($n = 28$) and a close family member ($n = 40$) were combined as the occurrences were very few. At wave one participants reported negative life events that had occurred over the youth's lifetime. At waves two to four, participants reported events that occurred during adolescence.

In order to investigate part A of the accumulation theory, it was determined when each challenge occurred, never, during childhood (0.99 years to 10.99 years) or during adolescence (11.00 years to 15.99 years). These three groups ($0 = none$, $1 = childhood$, and $2 = adolescence$) were defined using two dummy variables. As a result dummy one indicated the event occurred during childhood and dummy two indicated that the event occurred during adolescence.

Results

Preliminary analysis

Gender differences in predictors.

Table 1 displays the means and standard deviations for the age of pubertal timing and school transition. Growth spurt occurred approximately one year earlier in girls compared to their male counterparts. The dichotomous variable determining whether puberty co-occurred with school transition revealed that 153 girls (70.51%) experienced this double transition, while only 77 (40.74%) boys experienced it. A chi-square test of independence indicated that girls are significantly more likely to experience the double transition ($\chi^2(1) = 36.45, p < .05$, Fisher's exact = .00) in comparison to boys. This confirms the part of the accumulation which suggests that adolescent girls are faced with different and, in part, more co-occurring challenges than their male counterparts. Additionally, an independent-samples t-test indicated

that girls perceived significantly ($t(404) = 5.445, p = .000$) more rejection in subtle facial expressions ($M = -1.05, SD = .41$) compared to boys ($M = -.84, SD = .37$).

Table 1: Means and Standard Deviations of Pubertal Timing and Perceived Rejection.

	<i>N</i>	Girls		Boys	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age of Pubertal Timing ***	406	12.34	1.35	13.40	1.40
Age of School Transition	406	12	.00	12	.00

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

As indicated in Table 2, which presents the number of negative life events of the full sample of participants stratified by the two variables of interest (sex and age period at which the event happened), girls generally reported more negative life events in both childhood and adolescence. A chi-square test of independence was calculated comparing the frequency of divorce, psychological complaints, serious illness of oneself and serious illness of a close family member, in boys and girls. The only significant gender difference found was for psychological complaints ($\chi^2(2) = 2.98, p < .05$), indicating that girls were more likely to experience a psychological complaint than boys.

Table 2: Frequency and Percentage of Occurrence of Negative Life Events.

		Divorce	Psychological Complaints *	Serious Illness of Oneself	Serious Illness of Family Member
Boy	None	178 (94.18%)	169 (89.42%)	166 (87.83%)	150 (79.37%)
	Childhood	1 (0.53%)	2 (1.06%)	3(1.59%)	1 (0.53%)
	Adolescence	10 (5.30%)	18 (9.52%)	20 (10.58%)	38 (20.11%)
	<i>N</i>	189	189	189	189

		Divorce	Psychological Complaints *	Serious Illness of Oneself	Serious Illness of Family Member
	Childhood	6 (2.76%)	11 (5.07%)	9 (4.15%)	12 (5.53%)
Girl	Adolescence	11 (5.07%)	37 (17.05%)	17 (7.83%)	44 (20.28%)
	<i>N</i>	217	217	217	217

* $p < .05$, ** $p < .01$, *** $p < .001$ indicating significant difference between genders

A post hoc analysis indicated that it is particularly the psychological complaints experienced during adolescence which are responsible for the gender difference in psychological complaints. Furthermore, compared to boys, girl experienced significantly more psychological complaints during both childhood ($\chi^2 (1) = 5.24, p < .05$) and adolescence ($\chi^2 (1) = 4.89, p < .05$).

Correlations between predictors.

Table 3 displays the correlations between the variables, indicating that some of these challenges are not independent of one another. Firstly, adolescents who are more often seriously ill tend to perceive more rejection compared to those who are seriously ill less often. Secondly, adolescents whose parents are divorced were more likely to report psychological complaints in the family and of oneself, compared to those who come from non-divorced homes. Thirdly, adolescents who reported more psychological complaints experienced more serious illness themselves as well as a seriously ill family member. Finally, adolescents who reported being seriously ill themselves also commonly reported having a seriously ill family member.

Table 3: *Correlation Matrix for Predictors.*

	1	2	3	4	5	6
1. Pubertal Timing Co-Occurring with School Transition	1					
2. Perceived Rejection	-.02	1				
3. Divorce	-.04	-.03	1			
4. Psychological Complaints	-.03	-.04	.13**	1		
5. Sickness of Self	-.04	-.11*	.03	.25**	1	
6. Sickness of a Close Family Member	.01	-.04	.02	.17**	.16**	1

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

Main Results

The outcome variable was the highest CDI from all four waves. On average, girls received a slightly higher score on the CDI ($M = 9.79$, $SD = 6.73$), compared to boys ($M = 8.62$, $SD = 6.84$). Results for the hierarchical regression analyses are displayed in Table 4. These analyses were conducted in five steps. At the first step gender and age of the adolescent were entered as control variables. At the second step, the gender and age interaction was entered. Pubertal timing co-occurring with school transition and perceived rejection was entered at the third and fourth step respectively. Finally, at the fifth step, all negative life events were added. They were added together as some were found to be correlated. As psychological complaints was the only negative life event that significantly predicted adolescent depression it was the only one added to the final analysis.

Results from the hierarchical regression analysis predicting adolescent depression using the CDI revealed that neither gender nor age were significant predictors of adolescent depression (Model 1). Despite this, the gender variable was a predictor of adolescent

depression at trend level. The first model was not significant and accounted for less than one percent of the total variance in CDI scores. The same can be said for the gender and age interaction (Model 2). That is, the gender and age interaction was not associated with higher levels of depression. However, a non-significant trend was found. The gender and age interaction was negative indicating that as adolescent girls get older they become less depressed. The lack of significant gender differences made it impossible to study whether the added predictors could explain the gender difference in the development of depression. As such, the second model was not significant and did not explain even one percent of the variance in CDI scores.

With gender, age and the gender and age interaction controlled, pubertal timing co-occurring with school transition was a predictor of adolescent depression at trend level (Model 3). The third model was borderline significant but only explains one percent of the variance in the CDI scores. Perceived rejection was negatively linked with depression (Model 4), as expected. Perceived rejection was negatively coded which means that as an individual perceives more rejection they exhibit more depressive symptoms. This model was significant, however, it only accounted for approximately one percent of the variance in CDI scores.

With all previously added predictors controlled, psychological complaints during both childhood and adolescence were added (Model 5). As indicated by Table 4, model five significantly explains additional variance ($R^2_{\text{change}} = .03$). Specifically, it was the dummy indicating the complaints were reported during adolescence that contributed to this finding ($\beta = .18, t = 3.61, p < .001$). That is, during adolescence girls report significantly more psychological complaints than boys. These findings support part A of the accumulation theory which suggests that girls face more challenges that co-occur with adolescence which may place additional strain on their coping resources and heighten their risk for developing

depression. The final model was significant, whereby psychological complaints accounted for three and a half percent of the variance in CDI scores.

The overall model was significant ($F(2, 395) = 3.311, p < .01$), $R^2 = .088$, $R^2_{change} = .035$, $Sig. F_{change} = .001$, whereby it accounts for nearly 7% of the variance of CDI scores.

Despite only explaining a small percentage of variance, psychological complaints accounted for the majority (3.5%) of the total variance of the model.

Due to the many predictors, a set of analyses were conducted to investigate the part B of the accumulation which was interested in the co-occurrence of multiple risk factors and how their negative effects are strengthened. As above, gender and age were entered in model one and the gender and age interaction was entered in model two. In the third step all main effects were entered and at step four and five all possible two-way and three-way interactions were entered. Separate models were used to avoid power problems. No significant two-way or three-way interactions were found and therefore were not entered in the final regression model described above. These findings indicate that accumulation of multiple challenges co-occurring at the same time did not explain additional variance in this particular population (hypothesis B).

Finally, to test the alternative theory the main effects and gender were regressed in separate models to avoid power problems. This was done to determine whether girls value such challenges more negatively than boys (hypothesis C). Model one and two remained unchanged. Model three included all main effects and model four included the gender interaction. No interactions with gender were found to be significant indicating that girls and boys value challenges similarly.

Table 4: *Hierarchical Regression Analyses Predicting Depressive Symptoms from Perceived Rejection, Divorce, Serious Illness of Oneself, Serious Illness of a Close Family Member and Psychological Complaints.*

Predictors		β	t	p
Model 1	$\Delta R^2 = .009$.17
Gender		.08	1.69	.09
Age		-.04	-.79	.43
Model 2	$\Delta R^2 = .008$.08
Gender		1.33	1.90	.06
Age		.05	.75	.45
Gender and Age Interaction		-1.25	-1.79	.08
Model 3	$\Delta R^2 = .009$.06
Gender		1.16	1.66	.10
Age		.03	.38	.70
Gender and Age Interaction		-1.05	-1.50	.14
Pubertal Timing Co-occurring with School Transition		-.10	-1.92	.06
Model 4	$\Delta R^2 = .009$.05
Gender		1.05	1.50	.14
Age		.04	.49	.63
Gender and Age Interaction		-.96	-1.37	.17
Pubertal Timing Co-Occurring with School Transition		-.09	-1.79	.07
Perceived Rejection		-.10	-1.96	.05
Model 5	$\Delta R^2 = .034$.00
Gender		1.08	1.56	.12
Age		.03	.45	.65
Pubertal Timing Co-occurring with School Transition		-.09	-1.68	.10

Predictors	β	t	p
Perceived Rejection	-.11	-2.09	.04
Psychological Complaints During Childhood	-.03	-.68	.50
Psychological Complaints During Adolescence	.18	3.69	.00

Note: Gender is a dummy variable and the regression coefficients for the main and interaction effects of gender represent the value for girls.

Discussion

This study explored whether there was proof for the accumulation theory in explaining why girls are at a higher risk for developing depression during adolescence. This was tested against the alternative model which suggested that girls' value challenges more negatively than boys which is why they report more depressive symptoms. Depressive symptoms were assessed between the ages of 11 and 15. As such, they were expected to level off in girls whereas for boys they should not change much. This is because depression is episodic and the CDI score is not expected to increase dramatically in the next episode as an increase in depressive symptoms has already taken place.

Alternative theory – Do girls' value challenges more negatively than boys?

A gender interaction was not found with any of the predictors tested in the present study, therefore the alternative explanation can be rejected. Challenges are valued similarly by both genders and therefore, have a similar impact on girls and boys. However, other predictors may still show a gender interaction such as on-time versus off-time puberty timing (Conley & Rudolph, 2009). Consequently, future studies should investigate such a predictor.

Accumulation theory part A – Are girls faced with more risk factors than boys?

The main findings of this study support the first part of the accumulation theory which suggests that girls are confronted with more, and in part different, risk factors compared to

boys. The results confirm the hypothesis which states that certain challenges and negative life events that co-occur with adolescence will significantly predict adolescent depression and will occur more often in girls. Adolescent girls perceived more rejection and reported more psychological complaints compared to their male counterparts. Additionally, girls experienced pubertal timing co-occurring with school transition significantly more often than boys. As mentioned above these risk factors have similar relationships with later depression in boys and girls, the higher occurrence of these risk factors in girls can explain part of the gender difference in depression. Unfortunately this presumption could not be tested in the present study, because the gender difference in depression was not found to be significant in this sample.

Perceived rejection.

Consistent with expectations and literature (Downey et al, 1998; Boivin, Hymel, & Bukowski, 1995; Nolan, Flynn, & Garber, 2003; Panak & Garber 1992; Kupersmidt & Patterson, 1991; Chango et al., 2012; McDonald et al., 2010), perceived rejection was found to significantly predict depression in adolescents, however it only explained one percent of the variance in the CDI scores. It is thought that if one is uncertain, one may fear rejection and therefore perceive it more, which then hampers one's relationship development. However, it is unclear whether less meaningful relationships lead to increased sensitivity towards rejection, or if heightened sensitivity towards rejection results in suboptimal relationships. Thus, the bidirectional association between perceived rejection and adolescent depression merits further research. Furthermore, although the measure used to assess perceived rejection is highly reliable it only measures a small fraction of the tendency to perceive rejection. Future research should consider expanding the measure and interpreting signals other than facial expression, such as attractiveness.

It was found that girls perceived more rejection than boys. This is in line with the hypothesis and previous research which suggests that adolescent girls' place heightened importance on peer relationships (Rose & Rudolph, 2006; Buhrmester, 1998; Louw & Louw, 2014), have strong inclinations towards interpersonal caring (Hankin et al., 2015) and show exaggerated worries about peer appraisals (Louw & Louw, 2014; McDonald et al., 2010) compared to their male counterparts. Additionally, the content of friendships between girls and boys differs. Girls' friendships tend to be more focused on intimacy and one-to-one connection, with non-verbal communication becoming increasingly important, whereas boys' friendships often occur in groups with a focus on shared interests and activities (Louw & Louw, 2014; Rose & Rudolph, 2006; Buhrmester, 1998). As such, females tend to display an increased desire for social acceptance (Pickett, Gardner, & Knowles, 2004; Natsuaki et al., 2009) and be particularly sensitive to interpersonal challenges (Conley & Rudolph, 2009; Hankin et al., 2007), and are thus more vulnerable to developing depression.

Psychological complaints.

Not all negative life events significantly predicted adolescent depression. Psychological complaints were found to be a significant predictor of adolescent depression. This is in accordance with previous studies which highlights that depression is the most occurring complaint with any psychological disorder (Birmaher et al., 1996; McKowen et al., 2013; Oquendo et al., 2013), and that almost all psychological problems are a risk factor for depression (Mash & Wolfe, 2016; Birmaher et al., 1996; McKowen et al., 2013). These findings are well established for clinical levels of depression. As such, future studies would do well to replicate this study to examine if the same is true for milder versions of depression.

An interesting finding of the study was that psychological complaints were reported significantly more often by girls than boys. Social anxiety and eating disorders are known to

increase during adolescence, and are psychological complaints that happen to occur more often in girls. Additionally, if there are problems in the family girls may focus on them more than boys. Thus, it is possible that the increase in relevance of psychological complaints for girls occurs more so than for boys. Although these explanations supports the alternative theory it may be worthwhile investigating what other psychological problems tend to co-occur or precede adolescent depression.

Moreover, due to the low occurrence rate, the psychological complaints in this study were from both the individuals themselves and close family members. It is well-established that depression is commonly associated with other psychological complaints. Literature suggests that adolescents with parents who have psychological complaints may be at risk for developing depression due to the lack of availability of their parents (Burr, Good, & Delecchio Good, 1978). As such, future research should consider distinguishing psychological complaints experienced by a close family member (parents and siblings) and those experienced by the individuals themselves. In doing so, the underlying mechanisms related to the risk of depression may be better understood.

Furthermore, psychological complaints had age-specific effects, whereby the impact of such complaints was dependent on when it occurred, either during childhood or adolescence. When psychological complaints occurred during adolescence it significantly predicted higher depressive symptomology. As a result, this finding supports the hypothesis A which suggests that challenges that co-occur with adolescence contribute to the increased risk in developing depression and occur more often in girls.

Negative life events correlated with psychological complaints.

As displayed in Table 3, several negative life events were correlated with psychological complaints. These findings indicate that although events such as divorce are

not predictors of depression themselves and do not differ between boys and girls, they are related to psychological complaints which are a significant predictor of depression.

Therefore, these additional negative life events may indirectly increase the risk of developing adolescent depression. Despite not being a significant predictor of adolescent depression in this study, divorce was correlated with psychological complaints. Literature suggests that divorce is commonly associated with psychological issues as it has serious long-term health effects (Hill, 1993; Cherlin, Chase-Lansdale, & McRae, 1998; Fridrik, Jónsson, Njardvik, Ólafsdóttir, & Grétarsson, 2000; Marum, Clench-Aas, Nes & Raanaas, 2014; Homlong, Rosvold, Sagatun, Wentzel-Larsen, & Haavet, 2015; Ge et al., 2006). Divorce may trigger the onset of psychological issues as it results in emotional turmoil for the entire family (Ge et al., 2006). When these two events, divorce, and psychological complaints, co-occur they can be used to explain the gender difference in adolescent depression. Future studies would do well in investigating the correlations between psychological complaints and other risk factors found in this study are stronger in girls than in boys.

Additionally, psychological complaints are correlated with the serious illness of oneself, which was a predictor of depression in itself. Similar results have been found in other studies. For example, Leaverton et al. (1980) found that nearly one-third of all children with diabetes develop a severe emotional disorder later on in life. This correlation suggests that when an individual is seriously ill physically, they may also be ill in a mental sense, which increases their risk of developing depression. That is, if serious illness causes an increase in psychological complaints then it may predict depression indirectly. Furthermore, the serious illness of a close family member was also correlated with psychological complaints. When an individual becomes ill other members of the family alter their lifestyle which can cause disruption for the whole family and as well as an increase in stress which may lead to a heightened risk for psychological issues (Golics et al., 2013). Therefore, one event may

trigger another, and when they co-occur with adolescence they may increase the risk of developing depression.

Pubertal timing co-occurring with school transition.

It was hypothesised that pubertal timing co-occurring with school transition would significantly predict adolescent depression. However, when examining the relationships between the double transition and depressive symptoms, no significant relationships were found, contrary to expectations and a large body of literature (Louw & Louw, 2014; Graber, 2013; Beltz et al., 2014; Mendel, 2014) indicating a strong relationship between the two. Therefore, when this specific measurement of pubertal timing co-occurring with school transition is used this hypothesis must be rejected. Despite this, it is noteworthy that pubertal timing co-occurring with school transition is borderline significant indicating that those who experience the double transition have a greater risk of developing depression. Future research should use a stricter measure to examine the effects of pubertal timing co-occurring with school transition, for example by limiting the co-occurrence range of pubertal timing to six months before and after school transition takes places, rather than one year before and after.

The nonsignificant effect of the double transition in predicting depression may be due to the fact that associations between depression and pubertal timing co-occurring with school transition are more noticeable when examining clinical depression, and are not yet apparent when exploring depression symptoms in a normative sample. Future studies should measure pubertal timing as it occurs during development rather than relying on participants' memory. Moreover, this study could be repeated in order to see if pubertal timing co-occurring with school transition predicts CDI scores higher than 13.

Additionally, despite not being a significant predictor of adolescent depression, pubertal timing co-occurring with school transition occurred significantly more often in girls

than in boys. This double transition finding is consistent with expectations and literature which states that for girls' pubertal timing occurs more often in the same period as the progression to secondary school (Marcotte et al., 2002; Dubas & van Beek, in preparation; Nolen-Hoeksema & Girgus, 1994). Thus, it is clear that girls are confronted with different, and in part more, risk factors compared to boys.

Accumulation theory part B - Do multiple risk factors strengthen one another?

It was hypothesized that the co-occurring of multiple risk factors would strengthen one another's negative effects further increasing the likelihood of depression. In contrast to the hypothesis and other studies (Compas, 1987; Silberg et al., 1999), the risk factors in this study did not strengthen each other's negative effects as no interactions between any predictors were found to be significant. Thus, in the present study having two or more risk factors did not explain additional variance in adolescent depression. Perhaps the relatively small sample size and choice of risk factors investigated were responsible for this finding. As indicated in Table 2, the occurrence rate of each and any of the negative life events was very low. Due to this, the possibility of interactions to occur was even less. One possibility is to explore the number of risk factors as a predictor of adolescent depression rather than the types of risk factors faced by an individual. Future research should investigate whether other negative life events such as immigration and social and school problems predict adolescent depression. Moreover, further studies could make use of a high risk population whereby challenges or negative life events such a serious illness occur more often in order to be able to really reject this hypothesis.

Strengths, limitations and additional recommendations

The four-wave longitudinal design of the study is a noteworthy strength as it is particularly beneficial when aiming to predict episodic depression over time. Unlike similar

studies (Petersen, Sarigiani, & Kennedy, 1991; Dubas & van Beek, in preparation), the current study consistently utilized an accurate measure to assess depression. Additionally, perceived rejection was assessed in a largely unconscious way, with a new reliable measure. This is useful as facial expressions are interpreted similarly in everyday conversations. Although this new measure aids in understanding the mechanisms of perceived rejection in adolescents, future research should examine it in more depth.

Though this study is unique in examining the accumulation of a number of risk factors in predicting depression, some caution is warranted. For example, the outcome variable for this study was the participant's highest CDI from all four waves. Future studies that make use of this outcome variable would do well if they include the age at which the highest score is reported. Moreover, future studies should examine similar relationships in larger samples whereby gender is a significant predictor of adolescent depression. By doing so, the extent of these factors in explaining the gender difference can be better understood.

On a final note, although the overall model is significant, it only explains 6.9% of the variance in CDI. This is partly due to the fact that the study made use of a normative sample that was not selected to be particularly at-risk for high levels of depression. Additionally, as depression is a complex problem future studies should investigate additional negative life events or challenges that can possibly explain the rapid increase in adolescent depression. Research should further examine other negative life events such as immigration and social and school problems that may play a role, and which of these challenges specifically trigger adolescent depression.

Implications

Although these limitations present some restraint on interpreting the results with confidence, the current study does have a lot to add to the existing literature as well as

clinical practice. Examining the accumulation of negative life events and their co-occurrence with adolescence contributes to the ever-growing literature on adolescent depression and the gender difference in adolescent depression. Although this study is based on non-clinical measures of depressive symptoms, it has important health implications for the public as there is a compelling relationship between depressive symptoms in early life and the development of clinical depression in later life (Petersen et al. 1993).

Furthermore, preventative clinical efforts should focus on adolescents, especially girls, who display high sensitivity towards rejection and assist them with coping strategies to avoid the exacerbating effects of normal adolescent challenges. Additionally, clinicians' should pay more attention to adolescents who report psychological complaints from either their family or themselves. This should be done at both intervention and prevention levels to ensure that at-risk individuals receive the additional attention they require. As a final note for both researchers and practitioners, a single episode of depression is a significant risk factor for later episodes, thus, the long-term effects of developmental challenges should not be overlooked (Sheeber, Hops & Davis, 2001; Dubas & van Beek, in preparation).

Conclusion

The results indicate that challenges are valued similarly by both boys and girls. As such the alternative theory, which suggests that the gender difference in adolescent depression is due to the fact that girls' value challenges more negatively, can be rejected for the predictors in this study. Moreover, the presence of multiple co-occurring risk factors did not strengthen each other's negative effects. Thus, this part of the accumulation theory does not explain the gender difference in adolescent depression in this sample and can too be rejected. Despite this, this study confirms that several challenges tend to co-occur during adolescence, particularly for girls such as increased sensitivity towards rejection and psychological complaints. As such this, already stormy phase of life becomes even more

challenging for girls and overburdens their coping resources more so than boys, which may explain why girls, in general, run a greater risk of developing depression.

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Appendix A - Schematic Faces used to Measure Perceived Rejection

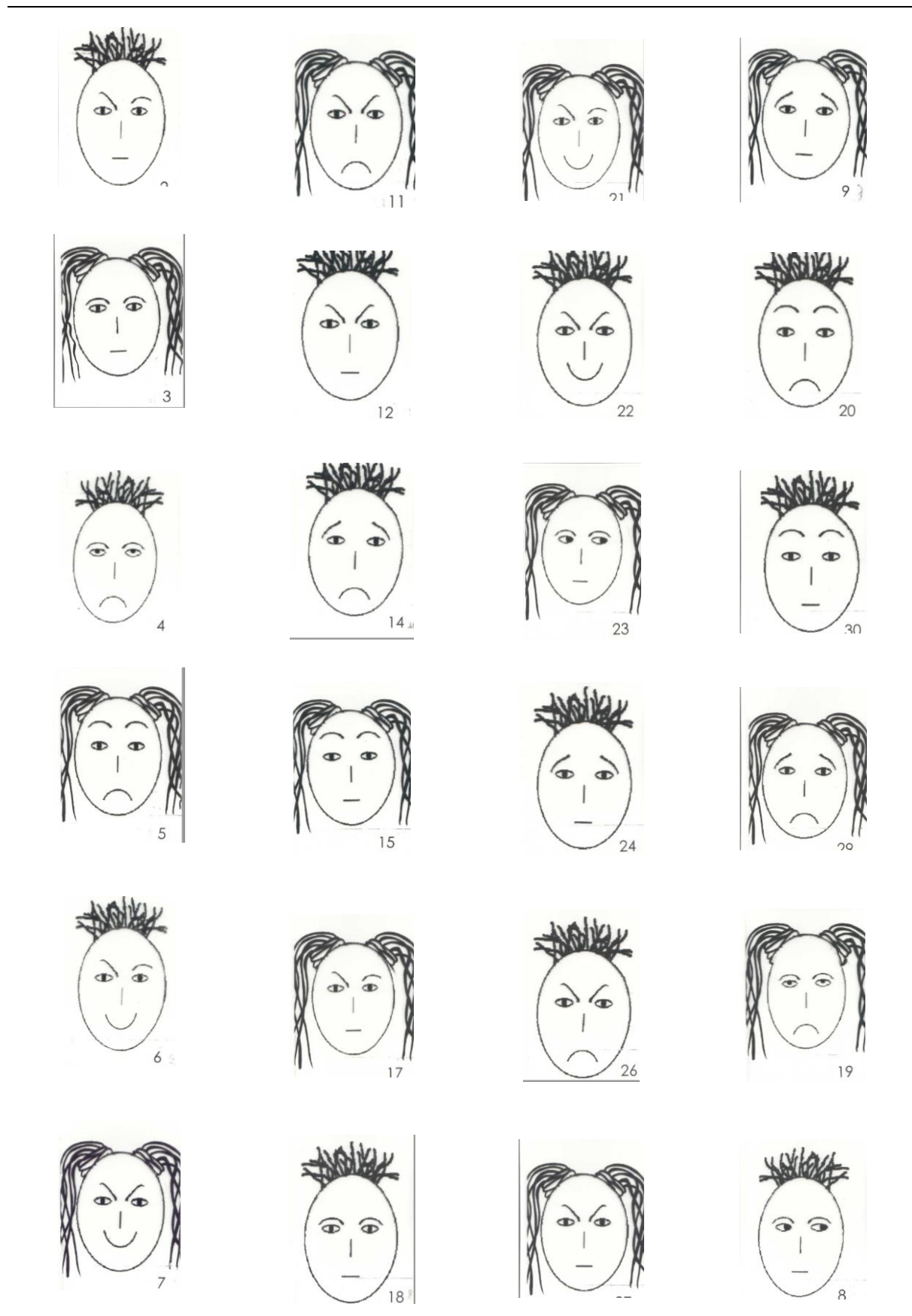


Figure 1. *Schematic faces used as perceived rejection measure*