# Self-Conscious Shyness: Growth during Toddlerhood, Strong Role of Genetics, and No Prediction from Fearful Shyness

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**Abstract**

Fearful and self-conscious subtypes of shyness have received little attention in the empirical literature. Study aims included: 1) determining if fearful shyness predicted self-conscious shyness, 2) describing development of self-conscious shyness, and 3) examining genetic and environmental contributions to fearful and self-conscious shyness. Observed self-conscious shyness was examined at 19, 22, 25, and 28 months in same-sex twins (MZ = 102, DZ = 111, missing zygosity = 3 pairs). Self-conscious shyness increased across toddlerhood, but onset was earlier than predicted by theory. Fearful shyness (observed [6 and 12 months] and parents' reports [12 and 22 months]) was not predictive of self-conscious shyness. Independent genetic factors made strong contributions to parent-reported (but not observed) fearful shyness (additive genetic influence = .69 and .72 at 12 and 22 months, respectively) and self-conscious shyness (additive genetic influence = .90 for the growth model intercept). Results encourage future investigation of patterns of change and interrelations in shyness subtypes.

*Keywords*: shyness, fear, self-conscious, heritability, twins

# Self-Conscious Shyness: Growth during Toddlerhood, Strong Role of Genetics, and No Prediction from Fearful Shyness

Many researchers have described various subtypes of shyness (e.g., Asendorpf, 1990; Colonnesi, Napoleone, & Bögels, 2014; Lewis, 2004; Rubin & Coplan, 2004). Few studies have examined shyness subtypes longitudinally in childhood. Researchers have speculated about the roots of shyness subtypes (Buss, 1986a), but have not empirically examined genetic and environmental influences on shyness subtypes. Understanding the development and etiology of shyness and its subtypes is important because shyness predicts outcomes such as anxiety, depression, and problems with peer relationships (e.g., Gazelle & Ladd, 2003), and subtypes of shyness may differentially relate to functioning.

Of interest in the present study, Buss (1986a, 1986b) distinguished between two subtypes of shyness - fearful shyness and self-conscious shyness. We examined fearful shyness at 6, 12, and 22 months of age and self-conscious shyness at 19, 22, 25, and 28 months of age.

## Distinctions between Fearful Shyness and Self-Conscious Shyness

Both fearful and self-conscious shyness may prompt inhibited social behavior. Elicitors and certain manifestations of fearful and/or shy behavior are theorized to differ and can be used to distinguish fearful and self-conscious shyness (Buss, 1986a, 1986b). According to this perspective, elicitors of *fearful shyness* include social novelty and intrusiveness (fast approach, close physical or psychological proximity). Infants' fearful shyness manifests as crying, distress, wary or fearful reactions, inhibited responding to strangers, retreat or escape, somatic anxiety, and seeking comfort (Buss, 1986a, 1986b; Cheek & Krasnoperova, 1999). Buss expected that after infancy, fearfully shy children may display inhibited speech in social situations and anticipatory worry. Buss (1986a, 1986b) theorized that fearful shyness involves a sympathetic autonomic nervous system response. *Self-conscious shyness* was described as the sense of being socially exposed, psychologically unprotected, the center of attention, and available to scrutiny, as well as awareness of one's self as a social object. Buss believed that self-conscious shyness occurs when one is receiving attention or is conspicuous, and when privacy is breached, when teased, when over-praised, or when interacting with authority figures (Buss, 1986a; Buss, 1986b; Schmidt & Buss, 2010). Self-conscious shyness manifests as embarrassment, blushing, disorganized behavior, and cognitive anxiety (Buss, 1986a, 1986b; Cheek & Krasnoperova, 1999). Buss (1986a, 1986b) hypothesized that extreme self-conscious shyness could activate a parasympathetic autonomic nervous system response. In children, the behavioral indicators differentiating these forms of shyness are signs of fear for fearful shyness, and signs of embarrassment for self-conscious shyness.

Lewis (2004) made a shyness/embarrassment distinction reminiscent of Buss's fearful/self-conscious shyness distinction. In Lewis's view, shyness is related to fear and discomfort when around others, but unrelated to self-evaluation. Embarrassment may be experienced either when exposed (e.g., when complimented, "on display," the object of others' attention) or, alternatively, as a result of negative self-evaluation of one's performance after violating a standard, rule, or goal (Lewis, 2001; 2008). Similarly, Buss conceptualized fearful shyness as related to fear, and self-conscious shyness as closely related to embarrassment (Buss, 1986a; Crozier, 2010). Buss's self-conscious shyness is conceptually similar enough to Lewis's embarrassment due to exposure (i.e., both involve embarrassment elicited when at the center of attention) to suggest they may have been describing the same phenomenon.

Buss (1986a) suggested that it is important to distinguish fearful shyness from self-conscious shyness because they have different origins, elicitors, and correlates. Obtaining a deeper understanding of these forms of shyness may bring greater precision to shyness research and help to better identify who may be at risk for later anxiety disorders or other maladaptive behaviors, who may become a socially cautious but healthy adult, and whose shyness may move to the middle of the population distribution over time.

**Literature Related to Fearful Shyness or Self-Conscious Shyness**

The literature contains an examination of the development of fearful shyness. Stranger wariness, which is classified as fearful shyness, emerges and increases during the second half of the first year of life (Bronson, 1972; Sroufe, 1977). Buss (1986a) argued that fearful shyness decreases as children develop coping skills and learn that strangers are not dangerous, but there is variation in that some children retain fearful shyness beyond infancy.

Limited evidence supports the earlier emergence of fearful shyness compared to self-conscious shyness. In a cross-sectional study, Crozier and Burnham (1990) interviewed children to assess perceptions of shyness. The frequency of responses that included elicitors of fearful shyness (e.g., a stranger) was similar across age groups (5/6, 7/8, and 10/11 years), whereas the frequency of responses that included elicitors of self-conscious shyness (e.g., speaking up in class) was greater in the oldest relative to the youngest group. Crozier and Burnham suggested self-conscious shyness might appear later than fearful shyness.

Rank-order stability in fearful shyness has been examined during infancy. Observed stranger wariness exhibits moderate rank-order stability during infancy (Bohlin & Hagekull, 1993), albeit not consistently (Andersson, Bohlin, & Hagekull, 1999; Hill-Soderlund & Braungart-Rieker, 2008) particularly in early infancy. Stranger wariness increases during the first year of life (Andersson et al., 1999; Hill-Soderlund & Braungart-Rieker, 2008).

Buss hypothesized fearful shyness to be heritable and partially influenced by genetically based fearful temperament. He also described potential environmental influences (e.g., lack of exposure to many social situations) on fearful shyness (Buss, 1986a). Results from twin studies have suggested that parent-reported shyness is affected by genetics and the environment. Children's parent-reported distress to novelty, as well as undifferentiated shyness, has been found to be influenced by both additive genetics (.58-.79) and nonshared environment (.21-.42; Eley et al., 2003; Goldsmith, Lemery, Buss, & Campos, 1999; Rhee et al., 2007). Shyness also has been found to be influenced by the shared environment (.28; Goldsmith, Buss, & Lemery, 1997). With regard to observational measures of fearful shyness, nine-month-olds' distress during stranger approach was influenced by additive genetics (.68) and nonshared environment (.32; Goldsmith et al., 1999). In addition, observed shyness toward strangers at 14 and 20 months of age was influenced by additive genetics (.44 and .19, respectively), and both shared (.12 and .53) and nonshared environment (.34 and .23; Cherny et al., 1994; 2001). In contrast, observed fearful shyness in middle childhood was not heritable (shared environment = .40, nonshared environment = .60; Clifford, Lemery-Chalfant & Goldsmith, 2013). Thus, findings vary across studies, but undifferentiated shyness and observed measures capturing fearful shyness have been influenced by additive genetics and/or the shared environment as well as the nonshared environment; genetics often (but not always) has had the largest influence.

In summary, the field has some information regarding onset, change, and genetic and environmental influence on young children's fearful shyness. There is limited, cross-sectional data regarding the onset of fearful shyness relative to self-conscious shyness.

**Gaps in the Fearful Shyness and Self-Conscious Shyness Literature**

Theoretical descriptions exist regarding the development of self-conscious shyness, the relation between fearful and self-conscious shyness, and genetic and environmental influence on young children's self-conscious shyness, but empirical evidence is lacking. Little is known about the onset, rank-order stability, or change in young children's self-conscious shyness, as defined by Buss. Buss believed self-conscious shyness would surface around 3 to 4 years of age as self-awareness and perspective taking emerge, and the capacity for experiencing embarrassment and other self-conscious emotions develops (Schmidt & Buss, 2010). However, Lewis has argued and found that embarrassment due to exposure occurs earlier and during the latter half of the second year of life, and embarrassment due to self-evaluation occurs after 24 months of age and probably closer to 3 years of age (see Lewis, 2001). Self-conscious shyness has been predicted to increase and peak in adolescence (Cheek & Krasnoperova, 1999). Studies in which both of Buss's subtypes have been examined were conducted with adults, are cross-sectional, or are based on retrospective reports (Schmidt & Buss, 2010).

To our knowledge, relations between children's fearful shyness and self-conscious shyness have not been examined. As was already described, origins, elicitors, cognitive and emotional experiences, and manifestations have been theorized to differ between fearful and self-conscious shyness, and thus they may be distinguishable forms of shyness (Buss, 1986a). In contrast, a study in which constructs somewhat related to fearful and self-conscious shyness were examined implies that they may be positively associated. For children who showed self-recognition at 22 months, those who had difficult temperaments (e.g., fearful, negative mood, non-adaptability) compared with those with easygoing temperaments in infancy were more likely to exhibit embarrassment at 22 months of age (DiBiase & Lewis, 1997). A difficult temperament encompasses more than fearful shyness, but these results are informative. An explanation for a potential relation between fearfulness or global negative emotionality and self-conscious shyness is that children who often display negative emotion in the company of others might have poor social experiences or be rejected by peers. If these negative experiences occur frequently, they might prompt feelings of inadequacy or negative expectancies regarding others, which may contribute to the development of self-conscious shyness (Rothbart & Mauro, 1990). Another reason fearful shyness may relate to self-conscious shyness is that children who avoid novel social situations may have fewer opportunities to develop social skills and confidence, which may contribute to self-conscious shyness (Crozier, 2010). Thus, the literature includes theoretical support for both a null and a positive relation between fearful and self-conscious shyness, but empirical evidence is lacking.

Although we know some about contributions to fearful shyness, reports regarding genetic and environmental contributions to children's self-conscious shyness or related constructs are absent from the literature. Buss suggested that self-conscious shyness might have roots in socialization (e.g., excessive parental criticism, history of teasing), high dispositional public self-consciousness, or low self-esteem (Buss, 1986b; Schmidt & Buss, 2010). We might suppose that self-conscious shyness would be influenced more by environmental than genetic variation. For example, having a parent who emphasizes appearance may contribute to children's concern about others' perceptions and awareness of one's self as a subject of others' evaluation. There also may be genetically influenced tendencies that affect self-conscious shyness. Although speculative, children may inherit predispositions for biased social information processing (Luebbe, Bell, Allwood, Swenson, & Early, 2010) that might contribute to interpreting others' behaviors or words as more judgmental than they are and self-conscious shyness.

In summary, many questions remain unanswered. We know little regarding the timing of onset of, stability of, change in, or genetic and environmental contributions to young children's self-conscious shyness, or about the relation between fearful shyness and self-conscious shyness.

**The Present Study**

We examined fearful shyness in response to strangers and self-conscious shyness in situations involving exposure, excessive attention, and over-praise. We view fearful shyness as inhibition or discomfort with unfamiliar people. We believe it requires a rudimentary sense of self in which the self is distinguished from unfamiliar and familiar others. Fearful shyness, which emerges during infancy (e.g., Bronson, 1972), was measured at 6-, 12-, and 22-months of age. We defined self-conscious shyness as embarrassment or discomfort when being the center of attention. We believe self-conscious shyness requires a more refined sense of self. Self-conscious shyness, which we expected to emerge during toddlerhood, was measured at 19-, 22-, 25-, and 28-months of age. In our view, self-conscious shyness becomes multifaceted with age (more complex self-representations, taking others' perspectives, self-monitoring, social evaluation concerns[1]). Self-conscious shyness stemming from more complex situations (e.g., worrying about being negatively evaluated by others), which we probably did not capture in this study, requires more sophisticated cognitive skills than self-conscious shyness due to exposure.

We aimed to address several of the gaps in the fearful and self-conscious shyness literature. A major gap in our understanding is the relation between fearful and self-conscious shyness. The first of our goals was to examine whether or not fearful shyness predicted self-conscious shyness. We wanted to a) report the zero-order relation, and b) examine prediction of the growth trajectory of toddler self-conscious shyness from infant fearful shyness. We expected a weak positive relation, given the transitions occurring between infancy and toddlerhood (e.g.,

[1] Buss (1986a) categorized sensitivity to social evaluation as a component of fearful shyness that emerges once cognitive skills are more developed. Asendorpf (1990) suggested that sensitivity to social evaluation is better classified as self-conscious than fearful shyness (see also Rothbart & Mauro, 1990), and we agree.

locomotion, language, self-regulation), and given the somewhat distinct theorized predictors and underpinnings of these types of shyness. We viewed this goal as an important first step in establishing the distinctiveness of fearful and self-conscious shyness.

Our second goal was to describe development of fearful and self-conscious shyness. With this goal, we targeted the gap in the literature regarding rank-order stability of, and change in, self-conscious shyness. We aimed to describe the a) rank-order stability of fearful and self-conscious shyness, and b) self-conscious shyness growth trajectory. Fearful shyness was believed to persist for some children after its onset, but we did not expect all children who would eventually demonstrate fearful shyness to exhibit it at six months of age. Thus, we predicted that fearful shyness would show rank-order stability with a medium effect size ($r \approx .30$). We projected that many self-consciously shy toddlers would retain that tendency, but believed that rank order might be somewhat upset over time due to differences in the timing of children's acquisition and development of self-concept or by environmental influences (e.g., parenting). Thus, we expected that self-conscious shyness would exhibit rank-order stability with a medium effect size (around $r \approx .30$). We believed self-conscious shyness might increase over time as children's self-awareness and more complex emotions develop.

The study's twin design permitted examining genetic and environmental contributions to fearful and self-conscious shyness, our third broad goal. Buss (1986b) expected fearful shyness to be influenced primarily by heritability, but self-consciousness to be influenced primarily by the environment. A behavioral genetic study allows us to test these ideas, and obtain novel information regarding genetic and environmental contributions to young children's self-conscious shyness. Investigating genetic and environmental contributions to fearful and self-conscious shyness and the potential relation between these shyness forms informs the amorphous distinctions between these subtypes. Accordingly, we aimed to describe genetic and environmental influence on individual differences in a) fearful shyness, b) the growth trajectory of self-conscious shyness, and c) the covariance of fearful and self-conscious shyness. We predicted that a genetic factor would have the primary influence on fearful shyness, with the environment having a secondary influence. We believed the environment would have the primary influence on self-conscious shyness's initial level and growth and the influence of genetics would be secondary. If fearful and self-conscious shyness covaried, we believed the covariance would be primarily due to environmental factors.

## Method

### Participants

This study was a part of a project designed to examine the genetic and environmental contributions to emotional development (*blinded*). The total sample in the present study consisted of $N = 446$ individuals (MZ = 102 twin pairs, DZ = 111 twin pairs, missing zygosity = 3) recruited into the project through birth records, mothers-of-twins clubs, television advertisements, newspaper birth announcements, doctors' offices, online searches, and referrals. Occasionally, twin pairs had missing data for one twin (e.g., twin was fussy or tired), and these twins were not included in numbers reported for twin pairs but were counted in numbers reported for individuals.

Because twin births are relatively rare, children were simultaneously recruited at 6, 12, and 19 months of age and followed longitudinally. Simultaneous recruitment was used to maximize enrollment (e.g., some families are unwilling to enroll when their twins are very young) and to span a wider range of ages. Thus, part of the sample had data for infant assessments at six ($M$ age = 6.24; $SD$ = .35) and/or 12 ($M$ age = 12.33; $SD$ = .53) months. At six months, 173 infants (58.5% female; MZ = 36 pairs, DZ = 47 pairs) had data. At 12 months, 281 infants (50.5% female; MZ = 64 pairs, DZ = 74 pairs, missing zygosity = 1 pair) had data.

Twins were tested in the lab when they were approximately 19 (*M* = 19.24; *SD* = .32), 22 (*M* = 22.23; *SD* = .35), 25 (*M* = 25.30; *SD* = .34), and 28 (*M* = 28.27; *SD* = .37) months. The sample at the 19-month visit consisted of 336 toddlers (58.3% female; MZ = 71 pairs, DZ = 82 pairs, missing zygosity = 2 pairs). The sample was 93.2% Caucasian, 2.4% African-American, 3.0% Hispanic, and .6% Asian-American (.9% was missing race data), which was representative of the region. Of families reporting income, 4.4% of the families made under $20,000 a year, 29.9% made $21,000-40,000, 36.6% made $41,000-60,000, and 29.1% made over $60,000. For fathers' education (mothers' in parentheses), 20.6% (10.2%) had some high school or graduated high school, 30.3% (34.0%) had some trade school or college, 29.0% (32.7%) were college graduates, and 20.0% (23.2%) had some graduate courses or held a graduate degree. The sample at 22, 25, and 28 months consisted of *n* = 375, 287, and 289 individuals (MZ = 86, 62, and 66 twin pairs; DZ = 97, 69, and 71 twin pairs; missing zygosity = 2, 0, and 0 twin pairs), respectively. Table 1 includes numbers of individuals and twin pairs with data for each measure.

We compared twins with data only during toddlerhood (*n* = 69 pairs) to twins with both infant and toddler data (*n* = 147 pairs). Chi-square tests indicated no differences in demographic variables. Mean differences in fearful (22 months) or self-conscious shyness (19, 22, 25, and 28 months) by group (toddlerhood data only vs. infancy and toddlerhood data) were examined with multilevel random intercept models using SPSS Mixed. Shyness was the outcome in each of these models and group was the level-2 predictor. The fixed-effect for group was never significant, indicating no differences.

**Attrition-relevant comparisons.** We made three comparisons to assess differences by attrition status across the toddlerhood visits: twin pairs with 1) data only at 19 months ($n$ = 14 pairs), 2) data only at 19 and 22 months ($n$ = 18 pairs), and 3) data only at 19, 22, and 25 months ($n$ = 20 pairs) were compared with twin pairs with data at 19, 22, 25, and 28 months ($n$ = 77 pairs). Reasons for attrition included time demands, leaving the area, and illnesses. Attrited versus non-attrited twin pairs were compared on zygosity (MZ vs. DZ), race (Caucasian vs. Non-Caucasian), family income (≤ vs. > 40K), fathers' education level (< vs. ≥ college graduate), and mothers' education level (< vs. ≥ college graduate) with Pearson $\chi^2$ tests. Categories were collapsed to reduce sparse data. Despite collapsing categories, results for race were invalid due to sparse data. Children with data only at 19 months differed from children remaining in the study; a greater proportion of children with less-educated fathers attrited, $\chi^2(1) = 5.09$, $p < .05$. Children with data only at 19 and 22 months differed from children remaining in the study; a greater proportion of males attrited, $\chi^2(1) = 5.62$, $p < .05$. Children with data only at 19, 22, and 25 months did not differ from children remaining in the study. Thus, only 2 (of 15 possible) comparisons indicated differences in demographics. In addition, mean differences in 19-, 22-, and 25-month self-conscious shyness by toddlerhood attrition status were examined with multilevel random intercept models using SPSS Mixed. Self-conscious shyness was the outcome in each of these models, and attrition status was the level-2 predictor. The fixed-effect for attrition status was never significant, indicating no differences.

**Procedure and Measures**

Questionnaires were mailed to families. Parents completed the demographic and zygosity questionnaires at the time of recruitment and again when twins were 19 months. All ages were adjusted for prematurity. Mothers and fathers completed the Infant Behavior Questionnaire (IBQ; Rothbart, 1981) when twins were 12 months, and the Toddler Behavior

Assessment Questionnaire (TBAQ; Goldsmith, 1996) when the twins were 22 months. For participants recruited during infancy, twins were assessed in the laboratory at six and/or 12 months. Twins also were assessed in the laboratory when they were 19, 22, 25, and 28 months. We required coders of observational assessments to establish agreement at Kappa = .80 for each behavior with a master coder before beginning their actual coding tasks. We did periodic consistency checks to assess and correct drift.

**Demographic and zygosity information.** Parents provided demographic information. Mothers completed the *Zygosity Questionnaire for Young Twins* (Goldsmith, 1991), which measures physical similarities. The agreement of the questionnaire with genotyping has been estimated at 96% (Forget-Dubois et al., 2003). In some cases, birth records contributed information on chorion type that established monozygosity. Parents of 14 twin pairs (12 MZ and 2 DZ) with uncertain zygosity consented to genotyping to determine zygosity.

**Observed fearful shyness.** Fearful shyness was assessed during the stranger approach episode in which a male experimenter wearing a hat knocked at the door, paused at the door (10-sec), began to approach the child who was in a highchair (10-sec), and then paused to say "Hello (*name*), I am going to be coming a little closer to you." The stranger completed his approach (10-sec), kneeled next to the child, gazed at the child’s eyes (2-min), and exited the room. The child’s mother was present (Laboratory Temperament Assessment Battery [Lab-TAB] manual; Goldsmith & Rothbart, 1999). This episode was considered a potential elicitor of fearful shyness because it entailed exposure to a novel person and mild intrusiveness (physical proximity).

Several behavioral indices of fear were coded for 30 epochs (4 during approach, 24 during gazing at child, and 2 during exit) from video at six and 12 months. Indices included intensity of facial fear (0 = *No facial region shows fear movement* to 3 = *An appearance change* *occurs in all 3 facial regions, or coder otherwise has impression of strong facial fear*), intensity of distress vocalizations (0 = *No distress* to 5 = *Full intensity cry [child is losing control]*), and escape behaviors (0 = *No escape behavior or social referencing* to 3 = *Vigorous escape behavior, intense full-body movements [e.g., arching back, twisting away, leaning away, hitting, pushing, and/or slapping]*).

Scores were averaged within fear index across the 30 epochs. If the episode was terminated early because the child became too upset, the average of the last two available epochs was extended to epoch 28 (the final epoch with the stranger present; Lab-TAB manual). Children's peak (highest) scores were obtained for each fear index. Correlations between mean and peak scores for facial fear ($r$s[170, 239] = .69 and .73, $p$s < .001), distress vocalizations ($r$s[167, 238] = .81 and .82, $p$s < .001), and escape behavior ($r$s[171, 239] = .66 and .69, $p$s < .001), were positive at six and 12 months, respectively, and averaged within index. Mean/peak facial fear, mean/peak distress vocalizations, and mean/peak escape behavior at six months, $r$s(166-170) = .24 to .49, $p$s < .01 to .001, and at 12 months, $rs$(238-239) = .11 to .49, $p$ = .23 to $p$ < .001, were standardized and averaged to form fearful shyness composites at six and 12 months.

**Parent-reported fearful shyness.** Parents rated (1 = *never* to 7 = *always*) infants' fearful shyness at 12-months of age using items from the Distress to Novelty scale of the IBQ (Rothbart, 1981). Five items that assessed fear of strangers were used (e.g., *When introduced to an unfamiliar adult, how often did the baby cling to a parent*; Goldsmith, 1996). An average of the five items was taken for mothers' reports and fathers' reports (αs = .88 and .86). Reporters had to have data for 4 of the 5 items to receive a score. Mothers' and fathers' scores were correlated, $r(176) = .59$, $p < .001$, and averaged to form a 12-month parent-reported fearful shyness composite. Participants could have missing data from one parent and receive a score on the composite (13.6% had reports from one parent).

Parents rated (1 = *never* to 7 = *always*) toddlers' fearful shyness at 22-months of age using items from the Social Fearfulness scale of the TBAQ (Goldsmith, 1996). Five items that assessed fear of strangers were chosen (e.g., *When your child was being approached by an unfamiliar adult while shopping or out walking, how often did your child show distress or cry?*). An average of the five items was taken for mothers' reports and fathers' reports (αs = .73 and .69). Reporters had to have data for 4 of the 5 items to receive a score. Mothers' and fathers' scores were correlated, $r(204) = .45$, $p < .001$, and averaged to form a 22-month parent-reported fearful shyness composite. Participants could have missing data from one parent and receive a score on the composite (28% had reports from one parent).

**Observed self-conscious shyness.** Self-conscious shyness was assessed during the compliments episode (adapted from Lewis, Stanger, Sullivan, & Barone, 1991). The child was asked to sit or stand on a small podium so the familiar experimenter could take a good look at how cute s/he is. Her/his parent was not always present. If present (*n*s = 244, 243, 200, and 176 individuals at 19, 22, 25, and 28 months, respectively), the parent was uninvolved and neutral. The experimenter gave three compliments (e.g., "Oh, look at those pants you've got on. They look so good on you. Let me take a picture so all my friends can see how cute you are!"). The experimenter took three pictures after each compliment. This episode was a good potential elicitor of self-conscious shyness because the child was socially exposed, the center of attention, and over-praised.

Several behavioral indices (Lewis et al., 1991) likely tapping the discomfort and embarrassment associated with self-conscious shyness were coded from videotape of the compliments episode at 19, 22, 25, and 28 months. Fidgeting (0 = *none*, 1 = *fidgeting not* *contingent with compliment/out of boredom*, 2 = *fidgeting contingent with the compliment*; rocking from side to side was not coded), lip biting/tongue protrusion (0 = *none*, 1 = *child bites lips or moves tongue*; lip biting/tongue movements that appeared to be out of physical effort [e.g., balancing] were not coded), and gaze aversion (0 = *none*, 1 = *averts gaze from the experimenter, sideways, or down*; orienting to other objects was not coded) were coded for 8, 5-sec epochs following each of the three compliments.

We computed a measure of self-conscious shyness by averaging the relative frequencies (number of times the child received the *highest* possible score divided by the number of epochs for which a score was received) of fidgeting, lip biting/tongue protrusion, and gaze aversion. Correlations among the indices were, $r$s(332-334) = .11 to .29, $p$s = .16 to $< .001$ at 19 months, $r$s(316) = .24 to .42, $p$s $< .01$ to .001 at 22 months, $r$s(285) = .25 to .46, $p$s $< .01$ to .001 at 25 months, and $r$s(286-287) = .22 to .32, $p$s $< .01$ to .001 at 28 months, respectively, and were averaged within time to form self-conscious shyness composites at 19, 22, 25, and 28 months. Self-conscious shyness means did not significantly differ at 19, 22, 25, or 28 months of age for toddlers' whose parent was present versus absent for the compliments episode. *P*-values for all Pearson correlations used an adjusted standard error ($\sqrt{1}/n$ [$n$ is the number of twin pairs]; Kenny, Kashy, & Cook, 2006).

**Latent Growth Model Methodology**

To examine growth in self-conscious shyness across 19, 22, 25, and 28 months of age, a latent growth model (LGM) was estimated with M*plus* (Version 7.11). Analogous LGMs were not computed for observed or parent-reported fearful shyness because they only had two measurement occasions each, and the questionnaire measure differed between 12 and 22 months. We followed Olsen and Kenny's (2006) recommendations for structural equation models with interchangeable dyads (e.g., same-sex twins) using a dyad-level data set. According to their recommendations, constraints were imposed to account for interchangeability. Equality constraints were imposed upon twin 1 and 2's means and twin 1 and 2's variances of the intercept and slope, intrapair covariances of the intercept and slope, interpair covariances of the intercept and slope, and time-specific residual variances of self-conscious shyness (see Figure 3 of Olsen & Kenny, 2006). The interpair covariance between twin 1's and twin 2's intercept, as well as the interpair covariance between twin 1's and twin 2's slope were estimated. Twin 1's and twin 2's self-conscious shyness residual variances were covaried within time. The factor loadings of self-conscious shyness corresponding to the intercept were fixed at one. The factor loadings of self-conscious shyness corresponding to the slope were fixed using time scores. Time scores allowed for each twin's slope factor loadings to depend upon their age at each observation. To compute time scores, the sample's mean age at the 19-month visit (1.60 years of age) was subtracted from children's age in years at each measurement occasion. Thus, the intercept represented model-implied self-conscious shyness at 1.60 years of age, and the slope represented model-implied change in self-conscious shyness per year. Based on the missing at random assumption, Full Information Maximum Likelihood (FIML) was employed for LGMs to utilize all available data.

**Twin Methodology**

Using structural equation modeling with the Mx program (Neale, Boker, Xie, & Maes, 2003), full univariate twin models were fit to decompose trait variance into components: additive genetic (A; the sum of the average effects of individual genes across the genotype), shared environment (C; aspects of the environment that make twins similar to one another), and nonshared environment (E; aspects of the environment that make twins dissimilar from one another and measurement error). C is shared between cotwins, and E is independent across cotwins. For MZ twins, A equals 1 because they share 100% of their genomic DNA. For DZ twins, A equals .50 because they share on average 50% of their genomic DNA. MZ twins are approximately twice as similar as DZ twins if similarity is only influenced by the additive influence of polymorphic genomic DNA. If shared environment also is important, DZ twins are more than half as similar as MZ twins, because shared environment, by definition, acts on members of MZ and DZ twin pairs the same way. We then fit reduced AE, CE, and E-only models to test the significance of each influence. E is never omitted because it includes measurement error. Fitting multivariate ACE models examining genetic and environmental influences on continuity and change across ages was not possible due to a limited sample size.

## Results

### Descriptive Statistics and Preliminary Analyses

Shyness variables were winsorized. Values exceeding 3 *SD*s from the mean were set to the score that was plus or minus 3 *SD*s from the mean. Skew and kurtosis of variables never exceeded |1|. Descriptive statistics are presented in Table 1.

Variables were examined for sex differences using multilevel random intercept models with SPSS mixed. A model was run for each fearful and self-conscious shyness variable, and sex was the predictor. The fixed-effect for sex was significant in just one model (of seven). Girls had higher self-conscious shyness at 25 months than boys, $\gamma_{01}(153.54) = -.05$, $p = .04$, 95% CI [-.098, -.001], girls' $M = .30$, boys' $M = .25$ ($n = 286$). Similar models were run with race/ethnicity as the predictor and no differences were obtained.

### Frequencies for 19-month Self-conscious Shyness

We examined the frequencies of self-conscious shyness to determine if it had emerged by

19 months of age. Only 11% of the sample at 19-months received a zero for this composite (demonstrated no signs of self-conscious shyness). The remaining distribution of 19-month self-conscious shyness was as follows: .01-.10 = 11.9%, .11-.20 = 17.9%, .21-.30 = 17.3%, .31-.40 = 20.5%, .41-.50 = 13.7%, .51-.60 = 5.7%, and .61 or higher = 2.1%. This pattern supports the emergence of self-conscious shyness prior to 19-months of age.

**Rank-Order Stability and Correlations between Fearful and Self-conscious Shyness**

Correlations are presented in Table 2. Pearson correlations were computed in SPSS using a pairwise data set that accounted for twin interdependence (Kenny et al., 2006). Infants' observed fearful shyness was not stable from six to 12 months, but parent-reported fearful shyness was highly stable from 12 to 22 months. Children's self-conscious shyness was moderately stable across time. Measures of observed and parent-reported fearful shyness were not related to observed self-conscious shyness.

**Latent Growth Models**

An LGM (*N* = 216 pairs [MZ pairs = 102, DZ pairs = 111, missing zygosity = 3 pairs]) for interchangeable dyads (Olsen & Kenny, 2006) was estimated for self-conscious shyness. The use of time scores in the model disallowed the computation of traditional fit indices. The means of the intercept and slope were .26, $p < .001$ and .06, $p < .001$, respectively. The variances of the intercept and slope were .01, $p < .001$ and .01, *ns*, respectively. Thus, on average, self-conscious shyness significantly increased across 19-, 22-, 25-, and 28-months. There were significant individual differences in the trajectory level, but not in rate of change.

A second LGM (*N* = 216 pairs [MZ pairs = 102, DZ pairs = 111, missing zygosity = 3 pairs]) was estimated to examine prediction of toddlerhood self-conscious shyness from fearful shyness during infancy. The self-conscious shyness intercept was regressed upon observed fearful shyness at six and 12 months, as well as parent-reported fearful shyness at 12 months (see Figure 1). Similar regressions were not computed for the slope, due to its non-significant variance. Estimated intrapair paths were constrained to be equal between twin 1 and 2, as were estimated interpair paths. Fearful shyness never significantly predicted the intrapair or interpair self-conscious shyness intercept.

**Quantitative Genetic Analyses**

Intraclass correlations (ICC) are presented in Table 1. They were computed in SPSS using multilevel random intercept models on a pairwise data set (Kenny et al., 2006) with the exception of the correlation for the self-conscious shyness intercept, which was computed using estimates of the intercept covariance and variance (i.e., $Cov_{12}/SD_1*SD_2$) obtained in LGM models run separately for MZ and DZ twins. Twin biometric models were fit to obtain accurate estimates of A, C, and E that take into account sample size and standard errors of estimates.

We fit saturated models to each measure of fearful and self-conscious shyness. With no exceptions, means and variances could be equated within and between zygosity groups, supporting the assumptions of the twin design. For example, for 12-month parent-reported fearful shyness, the saturated model yielded a fit of –2LL(195) = 607.11, AIC = 217.11, with equivalence across MZ and DZ groups for means, $\chi^2_\Delta(3) = 4.01$, $p = 0.26$, AIC = -1.99, and variances, $\chi^2_\Delta(2) = 1.01$, $p = 0.60$, AIC = -2.99. For 22-month parent-reported fearful shyness, the saturated model yielded a fit of –2LL(275) = 740.28, AIC = 190.28, with equivalence across MZ and DZ groups for means, $\chi^2_\Delta(3) = 2.93$, $p = 0.40$, AIC = -3.07, and variances, $\chi^2_\Delta(2) = 2.83$, $p = 0.24$, AIC = -1.17. Because variances were equivalent across zygosity groups, there was no evidence of sibling interaction effects (Neale & Cardon, 1992). Competition or contrast effects are distinguished from genetic effects because they result in higher total phenotypic variance in DZ than MZ twins.

Next, we fit univariate ACE models to observed fearful shyness at six and 12 months, parent-reported fearful shyness at 12 and 22 months, and the intercept representing toddler self-conscious shyness. Fit statistics and estimates of genetic, shared environment, and nonshared environment are presented in Table 3. Chi-square difference tests were used to determine the best model. Observed fearful shyness at 6 and 12 months were not heritable, with modest shared environmental influences (.33 and .34, respectively), and large nonshared environmental influences (.67 and .66, respectively). In contrast, parent-reported fearful shyness at 12 and 22 months were heritable (.69 and .72, respectively), with no evidence of shared environmental influence. To test for the possibility of nonadditive genetic influences (D), we also fit the ADE model for parent-reported fearful shyness at 12 and 22 months. The AE model was the most parsimonious and retained as the best fitting model, $\chi^2_\Delta(1) = 0.56$, $p = 0.38$, AIC = -1.24, and, $\chi^2_\Delta(1) = 0.96$, $p = 0.33$, AIC = -1.04, respectively. Toddler self-conscious shyness represented by the growth model intercept was strongly heritable (.90). Because there was little covariance between fearful and self-conscious shyness, we did not examine genetic and environmental contributions to the covariance.

## Discussion

In 1999, Crozier wrote, "Research has yet to establish the links between inhibition to the unfamiliar on the one hand and self-consciousness and concerns about being negatively evaluated by others on the other hand" (p. 16). A decade later, Schmidt and Buss (2010) called for developmental studies of infants and children to elucidate Buss's shyness theory. These are the first results from a longitudinal study that provide information about the interrelations and origins of young children's fearful and self-conscious shyness. We had three primary goals to address gaps in the literature: 1) determine whether or not fearful shyness predicted self-conscious shyness, 2) describe development of self-conscious shyness, and 3) examine genetic and environmental contributions to fearful and self-conscious shyness. Our results suggest that fearful shyness in response to a stranger is not predictive of self-conscious shyness elicited by exposure during toddlerhood. As expected, self-conscious shyness during toddlerhood increased over time. The evidence for genetic contributions to infant fearful shyness was mixed. The univariate genetic models suggested that observed fearful shyness at 6 and 12 months were attributed to environmental influences that were largely nonshared. In contrast, parents' reports of fearful shyness at 12 and 22 months were highly heritable. Similarly, the LGM intercept of observed self-conscious shyness was highly heritable.

**The Relation between Fearful and Self-Conscious Shyness**

The majority of prior theorizing led us to predict that fearful shyness and self-conscious shyness would be weakly positively correlated, but fearful shyness was not associated with self-conscious shyness either concurrently (22 months) or longitudinally (fearful shyness assessed at six and 12 months). Fearful shyness during infancy also did not predict the initial levels of self-conscious shyness in the LGM. Our results give credence to Buss's (1986a) notion that fearful and self-conscious shyness are distinct early in life.

One explanation for the lack of relation between fearful and self-conscious shyness is that they are distinct constructs. Perhaps fearful shyness is related to negative emotionality (Rothbart, Ahadi, Hershey, & Fisher, 2001). On the other hand, self-conscious shyness is related to a greater extent to more complex cognitive processes. Cognitive correlates of self-conscious shyness have been theorized, but are speculative and deserving of empirical examination (Buss, 1986b). Being the object of others' attention makes salient one's awareness of the self during early in childhood. Buss described this public self-awareness as a "focus on those aspects of the self that can be observed by anyone: body, face, clothes, speech, gestures, and manners" (1986b, p. 66). Later in childhood, the cognitive processes associated with self-conscious shyness are likely to be more complex, and may involve biased attributions, preoccupation with appearance and impression, and low self-esteem. For instance, low self-esteem may prompt people to feel inferior and that others are attending to them, which may evoke more maladaptive expressions of self-conscious shyness (Buss, 1986b).

Caution should be exercised when interpreting findings regarding the association between fearful and self-conscious shyness, given they have not yet been replicated and because they are null findings. It is important to entertain alternative explanations. It is possible that a relation exists but emerges later in childhood. This might especially be the case if fearful shyness leads children to have peer interactions that make later self-conscious shyness more likely, as Rothbart and Mauro (1990) suggested. Measurement of fearful shyness, peer relations, and self-conscious shyness later in childhood (e.g., during preschool) is needed to test this possibility.

Another alternative explanation is that the self-conscious shyness measure utilized in the present study did not distinguish ambivalent/positive self-conscious shyness (having simultaneous positive and negative feelings in social interactions) and painful self-conscious shyness (feeling distress in social interactions). Buss did not differentiate between ambivalent/positive and painful shyness. However, Reddy (2001, 2005) argued that shyness may be experienced positively. Indicators of interest behaviors (e.g., smiles) combined with indicators of avoidant behaviors (e.g., gaze aversion, nervous self-touching) would indicate ambivalent or positively experienced self-consciousness/coyness, whereas indicators of avoidance exhibited without interest behaviors would indicate painful self-consciousness. Our measures captured avoidant behaviors but did not capture interest behaviors in response to exposure to attention. Thus, it is possible that at least some of the self-consciously shy children experienced positive/ambivalent rather than uncomfortable or aversive shyness. Efforts to distinguish and compare self-conscious shyness that is aversive versus positive/ambivalent should be made in future research as the correlates may differ. For instance, toddlers' positive shyness was positively related to sociability and negatively related to social anxiety, whereas negative shyness was negatively related to sociability and unrelated to social anxiety (Colonnesi et al., 2014). It is possible that ambivalent/positive and painful self-conscious differentially relate to fearful shyness.

**The Development of Fearful and Self-Conscious Shyness**

We hypothesized that fearful and self-conscious shyness would both exhibit rank-order stability with a medium effect size. For fearful shyness, our hypothesis was partially supported. Little evidence of rank-order stability was found for observed fearful shyness from 6 to 12 months (i.e., the correlation was marginally significant, $p = .07$), a period of re-organization that usually includes intensification of fear toward strangers. In contrast, rank-order stability of parent-reported fearful shyness had a large effect size from 12- to 22-months of age. Our findings are somewhat consistent with previous research. Observed stranger wariness occasionally (Bohlin & Hagekull, 1993), but not always (Andersson et al., 1999) exhibits rank-order stability during infancy, whereas adults' reports often yield higher stability (Andersson, 1999; Sanson et al., 1996). Consistent with our hypothesis, self-conscious shyness showed significant rank-order stability with a medium effect size across 19, 22, 25, and 28 months of age, suggesting this form of shyness may be trait-like even during toddlerhood. Lewis et al.

(1991), using measures of embarrassment elicited by exposure similar to ours, also found some stability from 22 and 35 months of age.

We also hypothesized that self-conscious shyness would increase over time, on average. Consistent with that hypothesis, LGM indicated that self-conscious shyness significantly increased over time. As children's cognitive skills improve and sense of self forms, their reactions to being "in the spotlight" also appear to intensify. Individual differences were found for the intercept but not slope. Thus, toddlers' levels of self-conscious shyness at its earliest assessment differed from one another and they preserved those differences while showing increases in self-conscious shyness. It is possible that if we had measured self-conscious shyness in a variety of contexts we would have observed variability in rates of change over time. For example, an observational task that requires more of the child than simply receiving compliments, such as performing in front of others, might have captured a fuller range of individual differences in the development of self-conscious shyness across these ages.

Frequencies suggested that the vast majority of the sample exhibited at least some self-conscious shyness at its first measurement occasion; only about 11% of the 19-month sample did not exhibit signs of self-conscious shyness. Thus, onset of self-conscious shyness occurred earlier than would be predicted by Buss's theory (i.e., 3 or 4 years; Schmidt & Buss, 2010), and was more consistent with Lewis's descriptions of exposure embarrassment emerging near the middle of the second year of life (Lewis, 2001). Others also have observed children's self-conscious emotions during the second year of life. For example, 17-month-olds have been observed to exhibit embarrassment (Barrett, 2005). In an alternative view, Reddy (2005) proposed that "self-conscious" emotions may not require the awareness of the self, but only require "perceptions of the others' attention and emotion" (p. 198). Consistent with Reddy's argument, results have suggested that indicators of positive/ambivalent shyness, such as coy smiles toward a stranger, appear during the first year of life (Colonnesi, Bögels, de Vente, & Majdandžić, 2013).

In summary, children who were more self-consciously shy than their peers tended to remain this way over time, and self-conscious shyness increased during toddlerhood. The onset of self-conscious shyness appeared to take place prior to 19-months of age.

**Genetic and Environmental Contributions to Fearful and Self-Conscious Shyness**

We predicted that additive genetic influences would primarily contribute to individual differences in fearful shyness, in line with Buss's theory (1986a). Our hypothesis was supported by parent-reported fearful shyness, with additive genetic influence of .69 at 12 months and .72 at 22 months, but not observed fearful shyness at 6 and 12 months. Consistent with our findings, the limited behavioral genetic literature that utilized both parent report and observation supports the notion that parent-report indices are more highly heritable (e.g., Clifford et al., 2013; Saudino, 2003), and biometric analyses of parent-reported temperamental fear and undifferentiated shyness also yielded additive genetic influences (Eley et al., 2003; Goldsmith et al., 1997; Goldsmith et al., 1999; Rhee et al., 2007), with no influence of the shared environment (see Goldsmith et al., 1997 for exception).

In our study, the low similarity of observed fearful shyness at 6 and 12 months between both types of twins suggested modest shared (.33 and .34, respectively) and large nonshared environmental (.67 and .66, respectively) but not genetic influences. Shared environmental influences on observed fearful shyness may reflect frequency of exposure to social situations (Buss, 1986a), or parent over-solicitous (Rubin, Cheah, & Fox, 2001) or over-protective behavior. In addition to shared and nonshared environment, genetic influences on observed fearful shyness sometimes (Cherny et al., 1994, 2001), but not always (Clifford et al., 2013) have been reported. The advantages and disadvantages of adults' reports and observations have been treated extensively (Rothbart & Bates, 2006). Parents' reports average across multiple contexts across time, whereas observational assessments objectively capture behavior and context effects during a brief period of time. This does not mean observational measures are invalid; both are associated with important outcomes in developmental research, and we found that observed and parent-reported fearful shyness at 12 months were significantly associated.

This is the first study to report a biometric analysis of toddlers' self-conscious shyness. We hypothesized that the environment would have an influence on the initial levels and growth in self-conscious shyness. We were unable to examine genetic and environmental contributions to the self-conscious shyness slope because it lacked variability. Our hypothesis regarding initial levels was not supported, specifically, heritability accounted for a large portion of the variance in the LGM intercept (Table 3). Thus, heritable predispositions that predict self-conscious shyness, may be stronger contributors than putative environmental predictors. It is possible that environmental predictors, such as parents' criticism or emphasis on appearances, exert a stronger influence after toddlerhood.

Measurement issues such as contrast or assimilation effects may influence parents' ratings of twins' or siblings' temperament (e.g., Saudino, 2003), although we found no evidence of sibling interaction effects in our analysis. Importantly, Goldsmith and Campos (1990) found that 9-month-olds' distress during a stranger approach task did not differ between singletons and twins. Thus, we have some confidence that our results are generalizable to singletons.

**Limitations and Future Directions**

Our longitudinal design and sample of twins allowed for investigation of questions related to the development, interrelations, and origins of young children's fearful and self-conscious shyness. Despite addressing these questions, which have gone unanswered in the literature, the study had limitations that suggest a need for additional investigation. For example, it will be useful to observe fearful and self-conscious shyness in multiple contexts, perhaps using a battery of observations across a variety of situations. For instance, examining self-conscious shyness in the context of familiar peers and adults would be informative. In the present study, each form of shyness was observed in one context (although we also had parents' reports for fearful shyness). Thus, we likely only captured a part of what these forms of shyness are theorized to entail.

Furthermore, our sample size did not support the use of multivariate biometric twin models that estimated genetic and environmental influences on continuity and change across ages and developmental periods. Thus, we were not able to address contributions to the stability of self-conscious shyness across toddlerhood.

In addition to addressing our methodological shortcomings and replicating our novel findings, examination of physiological correlates would be a worthwhile undertaking to further understand the fearful shyness/self-conscious shyness distinction. Buss (1986a, 1986b) theorized regarding physiology associated with fearful and self-conscious shyness; specifically, that fearful shyness would be associated with sympathetic activation, and that self-conscious shyness sometimes would be associated with activation of the parasympathetic division. Kagan and colleagues' work with behaviorally inhibited children suggests that Buss may have been correct regarding fearful shyness (see Kagan, 2000). Behavioral inhibition is related to fearful shyness but is more broadly defined as it includes reactions to novel people, objects, events, and situations (Schmidt & Buss, 2010). Thus, behavioral inhibition is not the same as fearful shyness, but it is possible that some extremely fearfully shy children would be classified as behaviorally inhibited if they also were reactive toward nonsocial novelty. Research on adults' embarrassment and relations with parasympathetic activation is mixed (Gerlach, Wilhelm, & Roth, 2003; Leary, Rejeski, Britt, & Smith, 1996).

Finally, it is not yet clear if infants and toddlers who express fearful or self-conscious shyness will continue to express it, or if these forms of shyness are differentially related to outcomes. An investigation of stability into later childhood and beyond is needed. It will be interesting to learn whether the forms of shyness that are present early in life persist, and how they evolve with children's growing capabilities. Likewise, the associations of early onset fearful and self-conscious shyness with future problematic outcomes need to be investigated. While both fearful shyness and self-conscious shyness are normative responses, extreme standing can signal risk. For instance, infants' fearful shyness has been associated with internalizing problems (Karevold, Coplan, Stoolmiller, & Mathiesen, 2011). It remains to be seen if the tendency to display self-conscious shyness in toddlerhood is indicative of risk for maladaptive outcomes. Buss (1986b) hypothesized that the experience of self-conscious shyness might not be as intense as fearful shyness. If Buss is correct, it seems possible that self-conscious shyness would be less of a risk factor than fearful shyness. Additional research is needed to clarify implications for socio-emotional competencies and difficulties in the peer setting as well as psychopathology.

## Conclusion

Our results provide novel information about subtypes of shyness in early childhood. Self-conscious shyness increased with age and had a strong genetic influence. Parent-reported (but not observed) fearful shyness also had a strong genetic influence. Fearful shyness in response to a stranger during infancy did not predict self-conscious shyness elicited by exposure during toddlerhood. Our results are somewhat consistent with Buss's theory and, if replicated, imply that researchers should not use undifferentiated shyness assessments when evaluating young children. Perhaps this study will revive interest in different forms of shyness and serve as a starting point for new empirical assessments of children's fearful shyness and self-conscious shyness.

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Table 1

*Descriptive Statistics and Intraclass Correlations of Fearful and Self-conscious Shyness*

| | *n* | *M* | $M_{MZ}$ | $M_{DZ}$ | *SD* | $SD_{MZ}$ | $SD_{DZ}$ | *Number of Twin Pairs* | $ICC_{MZ}$ | $ICC_{DZ}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 observed fearful shyness | 173 | -0.01 | 0.15 | -0.14 | 0.73 | 0.82 | 0.63 | 83 [MZ = 36, DZ= 47] | .22 [-.10, .50] | .21 [-.08, .46] |
| 12 observed fearful shyness | 241 | 0.01 | 0.04 | -0.01 | 0.72 | 0.74 | 0.70 | 111 [MZ = 52, DZ = 58, $^{+}$ = 1] | .28 [.02, .51] | .30 [.03, .53] |
| 12 parent-reported fearful shyness | 204 | 4.32 | 4.24 | 4.41 | 1.18 | 1.17 | 1.18 | 102 [MZ = 51, DZ = 51] | .69 [.52, .81] | .27 [-.004, .50] |
| 22 parent-reported fearful shyness | 286 | 4.14 | 4.05 | 4.24 | 0.99 | 0.94 | 1.03 | 142 [MZ = 72, DZ = 70] | .70 [.56, .80] | .29 [.06, .49] |
| 19 observed self-conscious shyness | 336 | 0.26 | 0.26 | 0.26 | 0.17 | 0.17 | 0.17 | 155 [MZ = 71, DZ = 82, $^{+}$ = 2] | .24 [.01, .44] | .27 [.07, .45] |
| 22 observed self-conscious shyness | 318 | 0.27 | 0.26 | 0.28 | 0.18 | 0.18 | 0.18 | 144 [MZ = 62, DZ = 80, $^{+}$ = 2] | .44 [.22, .61] | .07 [-.14, .28] |
| 25 observed self-conscious shyness | 287 | 0.27 | 0.27 | 0.28 | 0.18 | 0.18 | 0.18 | 131 [MZ = 62, DZ = 69] | .34 [.10, .54] | .33 [.11, .52] |
| 28 observed self-conscious shyness | 289 | 0.30 | 0.28 | 0.32 | 0.18 | 0.18 | 0.18 | 137 [MZ = 66, DZ = 71] | .51 [.31, .67] | .24 [.01, .44] |
| Self-conscious shyness intercept | 432 | - | - | - | - | - | - | 216 [MZ = 102, DZ = 111, $^{+}$ = 3] | .73 [.63, .81] | .30 [.12, .46] |

*Note*. *n* = number of individuals, MZ = monozygotic, DZ = dizygotic, $^{+}$ = missing zygosity data, ICC = intraclass correlation [95% confidence interval], 6 = 6-month, 12 = 12-month, 19 = 19-month, 22 = 22-month, 25 = 25-month, 28 = 28-month. Occasionally, twin pairs had missing data for one twin, and these twins are not included in "number of twin pairs." SDs for self-conscious shyness differed for the total sample, MZ twins, and DZ twins, but the values appear the same when using two decimal places. The slope of self-conscious shyness did not have significant variance, and thus *ICC*s were not computed.

Table 2

*Correlations among Fearful and Self-conscious Shyness*

| | *1.* | *2.* | *3.* | *4.* | *5.* | *6.* | *7.* | *8.* |
|---|---|---|---|---|---|---|---|---|
| 1. 6 observed fearful shyness | - | $.22^{+}$ (131) | .01 (109) | -.04 (115) | .07 (146) | .01 (138) | -.04 (127) | -.04 (117) |
| 2. 12 observed fearful shyness | | - | $.25^{*}$ (162) | .13 (173) | -.07 (199) | -.05 (196) | .05 (164) | -.10 (158) |
| 3. 12 parent-reported fearful shyness | | | - | $.52^{***}$ (170) | .05 (172) | .02 (168) | .13 (149) | .03 (148) |
| 4. 22 parent-reported fearful shyness | | | | - | -.04 (221) | .07 (227) | .12 (217) | -.10 (214) |
| 5. 19 observed self-conscious shyness | | | | | - | $.30^{***}$ (259) | $.34^{***}$ (233) | $.38^{***}$ (222) |
| 6. 22 observed self-conscious shyness | | | | | | - | $.37^{***}$ (226) | $.29^{**}$ (226) |
| 7. 25 observed self-conscious shyness | | | | | | | - | $.36^{***}$ (222) |
| 8. 28 observed self-conscious shyness | | | | | | | | - |

*Note.* Pearson correlations were run on a pairwise data set. The *p*-values for all Pearson correlations were computed using an adjusted standard error (i.e., the square root of 1/*n* [*n* is the number of dyads]; Kenny et al., 2006). Degrees of freedom are in parentheses. 6 = 6-month, 12 = 12-month, 19 = 19-month, 22 = 22-month, 25 = 25-month, 28 = 28-month. $^{+}$ $p \leq .10$. $^{*}$ $p \leq .05$. $^{**}$ $p \leq .01$. $^{***}$ $p \leq .001$.

Table 3. *ACE Model Fit and Estimates of Genetic, Shared Environment, and Nonshared Environment Contributions to Fearful and Self-conscious Shyness*

| Measure | Model | *-2LL* | *df* | *AIC* | *Δdf* | *Δχ²* | *p* | $h^2$ | 95%CI$_{h^2}$ | $c^2$ | 95%CI$_{c^2}$ | $e^2$ | 95%CI$_{e^2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 observed | ACE | 132.41 | 163 | -7.59 | - | - | - | .00 | .00-.50 | .33 | .00-.51 | .67 | .48-.88 |
| fearful shyness | AE | | | -0.48 | 1 | 1.52 | 0.22 | .34 | .11-.53 | - | - | .66 | .47-.89 |
| | **CE** | | | **-2.00** | **1** | **0.00** | **0.99** | **-** | - | **.33** | **.12-.51** | **.67** | **.49-.88** |
| | E | | | 5.24 | 2 | 9.24 | <.01 | - | - | - | - | 1.00 | 1.00-1.00 |
| 12 observed | ACE | 492.11 | 217 | 20.11 | - | - | - | .00 | .00-.47 | .34 | .00-.49 | .66 | .49-.84 |
| fearful shyness | AE | | | 0.43 | 1 | 2.43 | 0.12 | .36 | .14-.54 | - | - | .64 | .46-.86 |
| | **CE** | | | **-2.00** | **1** | **0.00** | **0.99** | **-** | - | **.34** | **.16-.49** | **.66** | **.51-.84** |
| | E | | | 8.39 | 2 | 12.39 | <.01 | - | - | - | - | 1.00 | 1.00-1.00 |
| 12 months | ACE | 613.23 | 201 | 211.23 | - | - | - | .69 | .34-.80 | .00 | .00-.00 | .31 | .20-.47 |
| parent-reported | **AE** | | | **-2.00** | **1** | **0.00** | **.99** | **.69** | **.53-.80** | **-** | - | **.31** | **.20-.47** |
| fearful shyness | CE | | | 8.94 | 1 | 10.94 | <.01 | - | - | .48 | .32-.62 | .52 | .38-.68 |
| | E | | | 33.94 | 2 | 37.94 | <.01 | - | - | - | - | 1.00 | 1.00-1.00 |
| 22 months | ACE | 749.07 | 281 | 187.07 | - | - | - | .72 | .46-.81 | .00 | .00-.22 | .28 | .19-.41 |
| parent-reported | **AE** | | | **-2.00** | **1** | **0.00** | **0.99** | **.72** | **.59-.81** | **-** | - | **.28** | **.19-.41** |
| fearful shyness | CE | | | 15.29 | 1 | 17.29 | <.01 | - | - | .47 | .34-.59 | .53 | .41-.66 |
| | E | | | 49.54 | 2 | 53.54 | <.01 | - | - | - | - | 1.00 | 1.00-1.00 |
| 19-28 months | ACE | -1176.93 | 423 | -2022.93 | - | - | - | .86 | .60-.92 | .03 | .00-.29 | .10 | .08-.14 |
| intercept of | **AE** | | | **-1.96** | **1** | **0.05** | **.83** | **.90** | **.86-.92** | **-** | - | **.10** | **.08-.14** |
| self-conscious | CE | | | 62.90 | 1 | 64.90 | <.01 | - | - | .69 | .62-.76 | .31 | .24-.38 |
| shyness | E | | | 200.27 | 2 | 204.27 | <.01 | - | - | - | - | 1.00 | 1.00-1.00 |

*Note*. *-2LL* = –2 times the log likelihood. *df* = degrees of freedom. AIC = Akaike's Information Criterion. *Δdf* = change in degrees of freedom. $\Delta\chi^2$ = change in chi-square value from the full model to reduced models. $h^2$ = additive genetic, $c^2$ = shared environmental, and $e^2$ = nonshared environmental standardized squared parameter estimates. ADE models were also fit for parent-reported fearful shyness, but nonadditive genetic influences (D) were nonsignificant. The best-fitting reduced model is in bold.

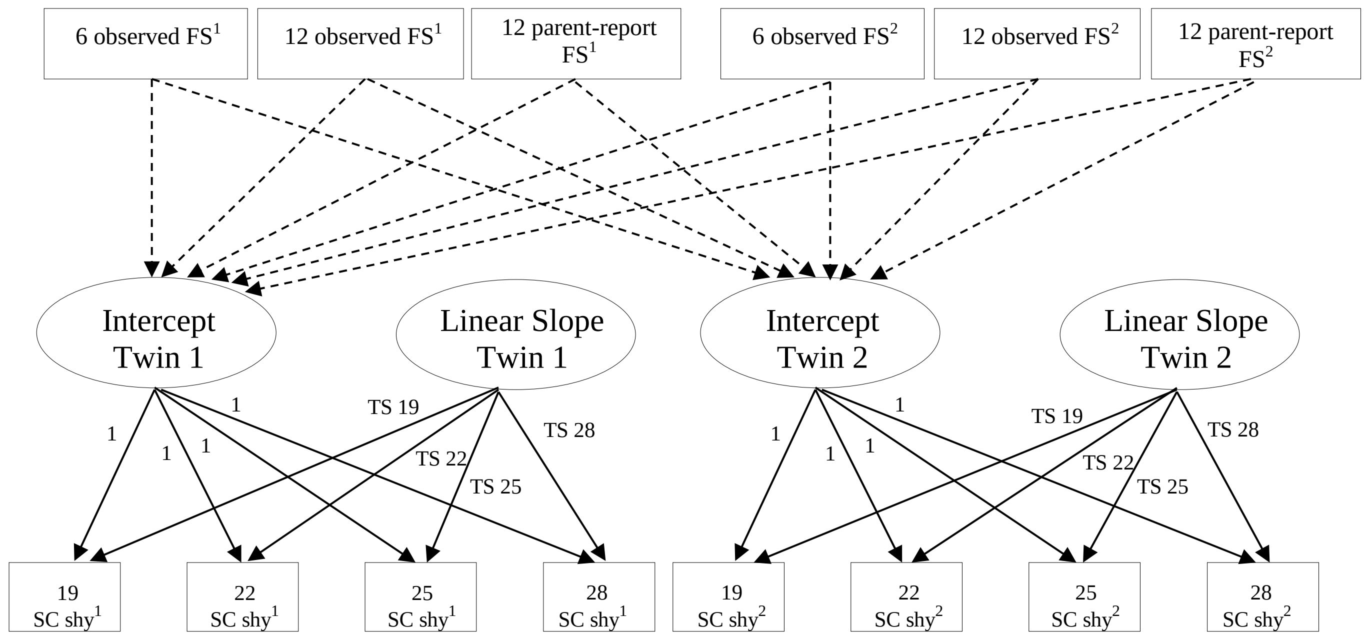


*Figure 1.* Latent growth model in which fearful shyness was used to predict self-conscious shyness. 6 = 6-month, 12 = 12-month, 19 = 19-month, 22 = 22-month, 25 = 25-month, 28 = 28-month, TS = time score, FS = fearful shyness SC = self-conscious shyness, [1] = twin 1, and [2] = twin 2. Dashed lines represent paths that were not significant at the .05 level. Covariances among latent intercepts and slopes, and covariances among residual variances are not depicted for clarity. Latent slopes were not predicted from fearful shyness due to non-significant variance.