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The Malleability of Behavioral Inhibition: A Study of Individual Developmental Functions

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A longitudinal study of children's individual developmental functions in observed inhibited behavior toward strangers and in teacher judgments of inhibition in school showed that IQ and teacher judgments of social competence predicted a decrease in both measures of inhibition over a 6-year period from ages 4 through 10 years. These findings suggest that, with increasing age, more intelligent or socially competent children can overcome inhibition in laboratory and school settings better than less competent children.

Over the last 30 years, children's inhibited behavior in unfamiliar situations has been the focus of continuing developmental research (Kagan & Moss, 1962; Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984; Thomas, Chess, Birch, Hertzig, & Korn, 1963). When children encounter a new environment, a stranger, or a novel object, they often show signs of an approach–avoidance conflict. Although they appear interested in the unfamiliar, they are hesitant to explore it. Inhibited motor activity, often resulting in a stiff body posture, prolonged looking at the novel person or object from a distance, and a long latency in first contact with the person or object, includes some of these overt indications of the approach–avoidance conflict (Asendorpf, 1990, 1991, 1992b; Coplan, Rubin, Fox, & Calkins, in press; Kagan, 1989; Kagan et al., 1984).

There are large interindividual differences in the extent to which children are inhibited toward the unfamiliar. These differences are moderately consistent across different unfamiliar situations (e.g., confronting adult or peer strangers), and they show moderate stability from the age of 2 years throughout childhood (Asendorpf, 1990, 1993; Broberg, Lamb, & Hwang, 1990; Bronson, 1981; Kagan & Moss, 1962), particularly when extreme groups of children high and low in inhibition are compared (Kagan et al., 1984; Kagan, Reznick, Snidman, Gibbons, & Johnson, 1988). Because of its early onset and a longitudinal stability that is high compared with other interindividual differences in childhood, inhibition toward the unfamiliar is often considered to reflect a temperamental trait (Kagan, 1989; Rothbart & Posner, 1985; Thomas et al., 1963).

Although most temperament researchers, including the authors cited earlier, share the view that temperamental traits show only a moderate longitudinal stability that is affected by differential genetic or environmental change, or by the differential acquisition of coping strategies (see, e.g., Kagan, 1989), there is a clear tendency in the temperament literature to focus on the stability and consistency of temperamental traits rather than on systematic instability and inconsistency. In particular, temperament research has rarely been concerned with interindividual differences in intraindividual behavior changes (*differential-developmental change;* e.g., inhibition toward strangers decreases more strongly over age in some children than in others). Such interindividual differences are regarded as measurement error in most cases, and if they are taken seriously, they are often discussed only in theoretical terms, citing single cases as empirical evidence (e.g., Kagan, 1989).

One of the few exceptions is Asendorpf's (1992a) study in which the year-to-year change in parental judgments of inhibition toward the unfamiliar was related to the stability of children's familial and extrafamilial social networks. In this longitudinal study, a pattern in which instability in the family network was not related to change in the inhibition judgments, whereas instability in the extrafamilial network was related to change in the inhibition judgments, was replicated across three 1-year periods. The more often children changed class or school, moved to another part of town, or lost a close friend who moved away, the more their inhibition toward the unfamiliar changed (up or down) according to parental reports—an indication of differential change due to differential stability of the social environment.

The aim of the present study was to apply another approach to the differential-developmental change in inhibition in the sample studied by Asendorpf (1992a). As far as can be judged from their overt behavior, children are stressed when they react with inhibition, and interviews with older children in the present sample suggested that already at age 4, they had experienced inhibition in the presence of strangers as being unpleasant and in need of change. Thus, even young children are expected to be motivated to overcome inhibition quickly (see also Asendorpf, 1991). It has been argued by Kagan et al. (1988) and Asendorpf (1991) that some children may learn to cope with inhibition-evoking situations better than others, for example, by acquiring better social skills for approaching strangers. The question in

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this study was whether it is possible to predict from the earlier measures of children's personality which children will later cope better with inhibition than others.

According to Sternberg's (1985) theory of intelligence, coping with novelty is a major feature of intelligence. Those who are highly intelligent find solutions to novel problems faster than those who are less intelligent, they automatize the solutions faster, and they find solutions that are more effective (see also Sternberg & Gastel, 1989). In unfamiliar social situations, high intelligence does not confer a direct advantage because the insecurity and fear aroused by the unfamiliar easily disrupt intelligent functioning. Therefore, intelligence as measured by traditional IQ tests shows only marginally negative correlations with inhibition toward the unfamiliar (Asendorpf & van Aken, in press; Kagan & Moss, 1962; Kagan et al., 1984).

However, intelligence may have a more subtle, indirect effect on inhibited behavior in the face of unfamiliarity. When people realize that they are inhibited in unfamiliar situations, find it distressful, and want to change it, generating alternative coping strategies and automatizing those strategies that have proved successful may be more likely with higher intelligence. The acquisition of coping strategies takes time, and therefore this effect of intelligence may be detectable only over a truly developmental time span, that is, after many years. According to this view, high-intelligent children are hypothesized to develop better coping strategies than low-intelligent children for unfamiliar situations. Thus, with increasing age, high-intelligent children's inhibition toward the unfamiliar should decrease more than low-intelligent children's inhibition. The present study tested this prediction by testing the relation between children's IQ and changes in inhibition toward an adult stranger as assessed by laboratory observations from the beginning of preschool at age 4 to age 10. Because children's IQ also shows some differential change over this age period, both early IQ (assessed during preschool) and late IQ (assessed during elementary school) were related to the differential change in inhibition.

A similar effect of intelligence was expected for differential change in another kind of inhibition: social-evaluative inhibition in familiar peer groups. Asendorpf (1990) found that over a 3-year period, children's inhibition during free play in their preschool class lost an initial correlation with inhibition toward strangers and instead became related to neglect and rejection by the increasingly more familiar classmates. Thus, both unfamiliarity and low peer acceptance can contribute to young children's inhibition in peer groups. Asendorpf (1990) and Asendorpf and van Aken (in press) proposed that low peer acceptance leads to inhibited behavior in the group if a child develops expectations of future peer nonacceptance (not all children develop these expectations, e.g., aggressive-rejected children).

In this case, interindividual differences in inhibition in familiar peer groups seem to arise from an at least partly nontemperamental source: the quality of social relationships with group members. However, despite a difference between inhibition in familiar groups and inhibition toward the unfamiliar, the coping effect of intelligence should apply to both kinds of inhibition in the same way. Those higher in intelligence should be better able to cope with negative peer relationships and the social-evaluative concerns that arise from them in the same indirect way in which they are better able to cope with unfamiliarity. Thus, inhibition in peer groups should decrease more among high-intelligent children than among low-intelligent children, irrespective of the familiarity of the group. This hypothesis was assessed by testing the relation between children's early and late IQ and changes in inhibition in class between the beginning of preschool and the end of elementary school as judged by their main teachers.

Although there are good reasons to expect that psychometric intelligence as assessed by IQ tests is related to the ability to generate and automatize coping strategies for social situations that arouse inhibition, this ability may also be related to particular aspects of social competence that are not strongly related to IQ (e.g., specific social skills; see Sternberg & Wagner, 1986; Waters & Sroufe, 1983). Thus, children's change in inhibition was related not only to IQ but also to a broad measure of social competence. Waters, Noyes, Vaughn, and Ricks (1985) proposed a Q-sort definition of social competence based on teacher judgments. Each child's teacher judges the child's personality with the California Child Q-Set (Block & Block, 1980). The child's Q-sort profile is then correlated with the Q-sort prototype of a socially competent child, and this correlation is interpreted as an overall index of the child's social competence. In the present study, a comparable index of social competence was computed on the basis of preschool teachers' Q-sorts (a German short version of the California Child Q-Set; Göttert & Asendorpf, 1989) and the same Q-sort prototype of a socially competent child that was used by Waters et al. (1985). This index was related to differential changes in children's inhibition in addition to their IQ scores.

In longitudinal studies, long-term developmental change is evaluated in most cases simply by computing a difference score between the final and the initial status of each subject in the sample, even when there are additional assessments between the beginning and the end of the study. Obviously, this is a poor approach because it ignores these additional assessments. Wohlwill (1973) had convincingly argued that developmentalists should study individual developmental functions that include more than two time points, but it took more than a decade before appropriate methods were developed for the statistical analysis of such functions (see Burchinal & Appelbaum, 1991, for an overview). Basically, each subject's full data set for one dependent variable is approximated by a particular type of function. In the most simple case, each subject's data are approximated by a straight line that is characterized by two parameters: level and slope. This can be done subject by subject by using an ordinary least squares approach that minimizes the quadratic distances of all individual data points from the line. Compared with the simple difference score, this approach has the advantage that the resulting individual developmental function (e.g., a straight line) is less affected by measurement error in the first and last assessment because all available data points are used for the estimation. In the present study, the individual developmental functions for inhibition toward strangers and inhibition in class were estimated using this ordinary least squares approach.[1]

[1] The results of the ordinary least squares approach were compared with (a) simple difference scores between the first and the last assessment and (b) Bayes estimates as proposed by Bryk and Raudenbush

Method

Subjects

The subjects for this study were recruited from the sample of the Munich, Germany, Longitudinal Study on the Genesis of Individual Competencies (LOGIC; Weinert & Schneider, 1986). This sample originally consisted of 194 children born between August 1980 and July 1981 who started to attend 20 preschools in the Munich area in the fall of 1984 and whose first language was German; after 1 year, another 25 subjects were added to the sample. This sample is unbiased because the schools were selected from a broad spectrum of neighborhoods, and more than 90% of the parents who were asked for permission gave their consent for their child's participation.

Those children who regularly attended preschool in the morning were selected for the behavioral observation studies of inhibition. Of these children, 88 were observed at 4 years of age in a laboratory confrontation with an adult stranger. Of these 88 children, 11 were lost over the next 6 years because of a change of residence, and another 3 were lost because these children or their parents refused to cooperate in the LOGIC study. Because of the low systematic attrition rate of 3%, no attempts were made to control statistically for subject attrition. The final sample for the analysis of inhibition toward strangers consisted of those 68 children (35 boys and 33 girls) who were observed at ages 4, 6, 8, and 10 years in a laboratory confrontation with an adult stranger, allowing one missing observation at either age 6 or 8.

From the full LOGIC sample, 193 children were judged by their preschool teacher for inhibition. Of these children, 146 entered Grade 1 in the fall of 1987 (mainstream children; others were early or late schoolers or were lost because of unsystematic attrition). For 71 mainstream children, teacher ratings of inhibition in class were obtained in Grades 1 and 4 (practical constraints forced the LOGIC team to obtain teacher ratings only from those teachers who had at least 2 LOGIC study children in their class). The final sample for the analysis of inhibition in class consisted of these 71 mainstream children (34 boys and 37 girls).

Procedure and Measures

Inhibition toward strangers. At the ages of 4, 6, 8, and 10 years, the children were confronted with an unfamiliar adult female. At 4 and 6 years, the stranger observation started with a preinteraction period during which the stranger attracted the child's attention with interesting toys but did not verbally approach the child. If the child did not initiate a conversation with the stranger within 3 min, the stranger tried her best to involve the child in a conversation. In any case, there was a preinteraction period of 0 to 3 min and an interaction period of 2 min following the first verbal initiation of the child or the stranger; both periods were videotaped (see Asendorpf, 1990, for a detailed description of this procedure).

At 8 and 10 years, the preinteraction period was no longer considered age appropriate, and it was changed as follows. The child met a female adult stranger who was sitting at a table in the observation room; the stranger invited the child to sit down opposite her. The stranger started a conversation about visiting a circus (age 8) or the last birthday party (age 10), events that every child had experienced. She asked only short questions (e.g., "Have you been to a circus?") and waited up to 10 s if the child did not respond. After each answer from the child, she waited 10 s before she asked the next question. This slow interviewing style put the burden of the conversation on the child. The interviewer had a repertoire of six questions available. Every interview lasted at least 2 min and was videotaped.

All videotapes of an assessment were presented to the same group of observers. Different students served as observers for different assessments (four observers for the 4-year-olds and two for the 6-, 8-, and 10-year-olds). The observers rated the subject's inhibition after each minute (4- and 6-year-olds) or after the first, second, and third 30-s period (8- and 10-year-olds) on a 7-point scale (1 = *not at all* to 7 = *very much*) labeled *shy–inhibited.* All observer ratings were averaged across phases, yielding one inhibition score per child and observer. These scores showed a high interobserver agreement (α = .97 for the 4-year-olds, .89 for the 6-year-olds, and .93 for the 8- and 10-year-olds).

Detailed correlational analyses of various behavioral measures, including nonverbal ones such as gaze aversion or self-stimulation, the observer judgments, and independently assessed parental judgments of inhibition toward strangers at ages 4 and 6, showed that the single most valid behavioral indicator of inhibition in this situation was the latency of the first spontaneous utterance of the child (see Asendorpf, 1992b, for details). Comparable analyses at ages 8 and 10 indicated that inhibition was best operationalized at these ages by the percentages of silence during the conversations. This conclusion was further supported by the finding that the long-term stabilities between the early latency measures and these percentages were somewhat higher than the stabilities between the early and the late latencies. Therefore, inhibited behavior was operationalized by the latencies at ages 4 and 6 and the percentages of silence at ages 8 and 10 years.

Two observers independently coded the latencies (in seconds) of children's first unsolicited utterance directed to the stranger at ages 4 and 6 (intercoder rs = .93 and .94; coding disagreements were resolved by consensus). Another observer coded children's on–off pattern of speech at age 10 by pressing a button on a microcomputer when she viewed the videotapes of the assessment in real time. Interobserver agreement for the speech coding was assessed by an independent coding of 10 children and can be considered to be sufficiently high (κ = .76). At age 8, children's speech was automatically assessed by a small, portable microcomputer that recorded the on–off pattern of speech on a time base of 8 ms by way of a condenser microphone that was attached to the child's throat. The concurrent correlations between the observer judgments and the behavioral measures of inhibition were .76 (age 4), .79 (age 6), .58 (age 8), and .65 (age 10).

Inhibition in class. A 54-item German short version of the California Child Q-Sort (Block & Block, 1980; Göttert & Asendorpf, 1989) was answered by the child's main preschool teacher when the child was 4, 5, and 6 years of age toward the end of each school year; 4 children had a missing value at age 6. Each child's Q-sort profile was correlated with a prototypic Q-sort of a "shy–inhibited child" that was provided by four preschool teachers with high agreement (α = .92). This correlation served as the child's score of inhibition in class (see Asendorpf, 1990, for more details). At 7 and 10 years of age (toward the end of Grade 1 and Grade 4), the child's main elementary school teacher (who was always different between Grades 1 and 4) rated the child's inhibition in class on a 9-point scale (1 = *not at all* to 9 = *very much so*).

Social competence. The child's social competence in preschool was similarly assessed by correlating the child's Q-sort profile with the prototypic Q-sort of a socially competent child that was provided by North-American psychologists (Waters et al., 1985); the three correlations per child (obtained at ages 4, 5, and 6) were then z transformed in the full sample and were averaged, yielding one highly aggregated score (α =

(1987). The Bayes estimates were weighted scores consisting of the ordinary least squares estimates and the mean change in the sample as the between-subjects predictor. Not surprisingly, the difference scores produced weaker results than the ordinary least squares approach. The Bayes estimates had a slightly lower reliability and produced slightly weaker results than the ordinary least squares estimates, probably because the choice of the mean change in the sample as the between-subjects estimate (due to a lack of stronger between-subjects predictors) led to a too conservative estimation of differential change.

.76). The Q-sort indexes of children's social competence and inhibition in class were not significantly correlated for all 3 years of assessment.

Intelligence. Verbal intelligence was assessed with the German versions of the Wechsler scales for preschool children at 4 and 5 years (Eggert, 1978) and for school-age children at 7 and 9 years (Tewes, 1983). Nonverbal intelligence was assessed with the Columbia Mental Maturity Scale (Burgemeister, Blum, & Lorge, 1972) at 4, 6, and 8 years, and with the German version of the Culture Fair Intelligence Test (Weiβ & Osterland, 1979) at 10 years. To obtain more reliable indexes of preschool and school verbal and nonverbal intelligence, the two verbal and the two nonverbal tests within each age period were z transformed in the full sample and were averaged (αs = .62 for early verbal, .71 for early nonverbal, .89 for late verbal, and .70 for late nonverbal). These indexes showed moderate correlations between verbal and nonverbal IQ for both age periods (.44 for preschool and .56 for school). Therefore, all four IQ scores within each age period were also z transformed in the full sample and were averaged, yielding highly aggregated IQ scores for preschool and school intelligence (αs = .71 and .80, respectively). The mean age at the four assessments of preschool intelligence was 5 years (comparable with the mean age of preschool social competence), and the mean age of the four assessments of school intelligence was 8 years.

Results

Overlap and Selectivity of Samples

The samples for the assessment of inhibition toward strangers (n = 68) and for the assessment of inhibition in class (n = 71) showed a moderate overlap (39 children participated in both samples). Potential selection biases in the two samples for inhibition, social competence, and intelligence were evaluated by t tests that compared each sample with the other LOGIC subjects in the first year of the study for the Q-sort indexes of inhibition and social competence and for IQ (these three measures were assessed for nearly all of the LOGIC subjects). For the stranger inhibition sample, no significant differences were found. The class inhibition sample did not differ significantly from the other LOGIC subjects in inhibition and social competence in the first year of the study but was biased toward higher IQ, $t(176) = 2.11$, $p < .03$. This difference can be attributed to the exclusion of late schoolers from the sample.

Inhibition Toward Strangers

The 2 × 4 measures of inhibition toward strangers were z transformed in the full sample because their scales were not comparable. This standardization led to subsample means and standard deviations that were close to zero or one. Thus, changes in means of inhibition could not be examined, but interindividual differences in inhibition status and change could be analyzed and related to external variables.

Table 1 contains the intercorrelations of the 2 × 4 measures of inhibition toward strangers, preschool social competence, and preschool and school IQ. The correlations involving the latency scores were corrected for a ceiling effect in these scores according to the method proposed by Alliger, Hanges, and Alexander (1988; at age 4, 38% of the sample reached the maximum latency of 300 s, and at age 6, 13% of the sample reached the maximum latency).

Table 1 indicates moderate stabilities for the measures of inhibition. An exception were the age 6 data, which showed a high correlation with the age 4 data but low correlations with the age 8 and the age 10 data. The correlations between the inhibition measures and the measures of social competence and intelligence showed a trend toward more negative correlations with increasing age at the assessments of inhibition. However, most of these correlations were nonsignificant. The increasing negativity of the correlations between inhibition and IQ or social competence was tested for significance as follows. For each measure of IQ or social competence, its correlation with inhibition at age 4 was contrasted with its correlation with inhibition at age 10 by Z^* tests for differences between correlations in the same sample (Steiger, 1980). For all predictors, the correlations with the two measures of inhibition at age 10 were significantly more negative than the correlations with the same measure of inhibition at age 4 (in each case, $Z^* > 2.31$, $p < .03$). Social competence showed significant but low correlations with IQ, and IQ showed a moderate stability between the preschool and elementary school years.

Inhibition in Class

Table 2 contains the intercorrelations of the five assessments of inhibition in class, preschool social competence, and preschool and school IQ. This table can be directly compared with Table 1; the intercorrelations among the IQ and social competence measures are very similar to those in Table 1 because of the identical measures and the overlapping samples.

The measures of inhibition showed moderate to low stabilities. The correlations involving elementary school data are attenuated because these data consisted of only one rating per teacher, whereas the preschool data were more highly aggregated (Q-sort index). The correlations between the inhibition measures and the measures of social competence and intelligence showed again a trend toward more negative correlations with increasing age at the assessments of inhibition. And again, most of these correlations were nonsignificant, and Z* tests indicated that for each of the three measures of competence, the correlation with inhibition in Grade 4 was more negative than the correlation with inhibition at the beginning of preschool (in each case, $Z^* > 2.20$, $p < .05$).

Analysis of Individual Developmental Functions

Children's linear individual developmental functions were estimated by ordinary least squares estimation by using the PC version of the hierarchical linear model program by Bryk, Raudenbush, Seltzer, and Congdon (1989). Each developmental function could be characterized by two individual parameters that were simultaneously estimated: the level of inhibition (the estimated inhibition at the midpoint of the observation interval, representing the main effect of inhibition for the age interval under study) and the slope of the straight line representing the developmental function. One reason to prefer level to the initial status at age 4 is that the correlation between level and slope is often smaller than the correlation between initial status and slope.

The ordinary least squares estimates for level and slope were inspected for outliers, and the distributions of the residuals of the estimated inhibition scores for each point in time were in-

Table 1
Intercorrelations of the Measures of Inhibition Toward Strangers, Social Competence, and Intelligence

Measure/age (years)	1	2	3	4	5	6	7
Stranger inhibition							
1. Age 4	—	.74	.59	.44	.32	.25	.24
2. Age 6	.58	—	.33	.05	.33	.12	.01
3. Age 8	.52	.30	—	.62	.06	−.13	−.26
4. Age 10	.32	.22	.56	—	−.09	−.14	−.23
Social competence							
5. Age 4–6	.10	.30	−.10	−.23	—	.42	.29
Intelligence							
6. Age 4–6	.11	−.05	−.17	−.32	.42	—	.58
7. Age 7–10	.01	−.05	−.18	−.38	.15	.59	—

Note. $N = 68$. Reported are Pearson correlations (for $r > .26$, $p < .05$). Correlations above the diagonal refer to inhibited behavior, those below the diagonal to observer judgments of inhibition. Correlations involving latency scores at ages 4 and 6 were corrected for ceiling effects in the latency scores.

spected for outliers and were analyzed for possible dependencies on age (such dependencies would indicate that nonlinear developmental functions might be more appropriate). No outlier problems and no systematic dependencies were found. Thus, linear developmental functions appeared to be the best choice.

The sample means were −0.021 (level) and 0.014 (slope) for inhibited behavior toward strangers, −0.057 (level) and 0.018 (slope) for the observer judgments of inhibition toward strangers, and −0.056 (level) and 0.005 (slope) for inhibition in class; they were not significantly different from zero according to t tests (thus, there was no significant selection bias for these parameters). The standard deviations were 0.778 (level) and 0.182 (slope) for inhibited behavior toward strangers, 0.637 (level) and 0.174 (slope) for judged inhibition toward strangers, and 0.707 (level) and 0.210 (slope) for inhibition in class; they were highly significantly different from zero according to chi-square tests, indicating substantial interindividual differences in level and slope.

The standard deviations for the slopes can be interpreted as follows (see Bryk & Raudenbush, 1987). A standard deviation of 0.182 for the slope of the functions for inhibited behavior toward strangers means that a child whose inhibition toward strangers increases one standard deviation above the average change shows an increase of $0.014 + 0.182 = 0.196$ z scores in inhibition per unit of time (which is 1 year here). Such a child would arrive at an estimated final status in inhibition that is $6 \cdot 0.196 = 1.176$ z scores higher than the child's initial status. Similarly, a child whose inhibition decreases one standard deviation below average shows a decrease of $0.014 - 0.182 = -0.168$ z scores per year. For two of the three inhibition measures, level and slope showed low negative correlations across the children (for the behavioral measure of inhibition toward strangers, $r = -.21$; for inhibition in class, $r = -.11$); thus, level and slope could be analyzed separately in these cases. For the judgmental measure of inhibition toward strangers, level and slope were moderately correlated ($r = -.46$); therefore, slope was also analyzed when level was partialed out.

In addition to these parameter estimates, the reliability of the level and slope parameters can be estimated (see Bryk & Raudenbush, 1987, for details). For inhibition toward strangers, the overall reliabilities for level were .79 (behavior) and .81 (judgment), and for slope .30 (behavior) and .49 (judgment); for in-

Table 2
Intercorrelations of the Measures of Inhibition in Class, Social Competence, and Intelligence

Measure/age (years)	1	2	3	4	5	6	7	8
Class inhibition								
1. Age 4	—	.62	.42	.23	.22	.13	.06	.11
2. Age 5		—	.63	.30	.18	.17	.21	.12
3. Age 6			—	.26	.37	−.03	.01	.00
4. Age 7				—	.32	−.16	−.25	−.31
5. Age 10					—	−.20	−.30	−.25
Social competence								
6. Age 4–6						—	.42	.15
Intelligence								
7. Age 4–6							—	.59
8. Age 7–10								—

Note. $N = 71$. Reported are Pearson correlations (for $r > .24$, $p < .05$).

Table 3
Correlations Between the Level and the Slope of the Individual Developmental Functions for Inhibition Toward Strangers and Inhibition in Class, and Social Competence and Intelligence

	Stranger					
	Behavior		Judgment		Class	
Predictor	Level	Slope	Level	Slope	Level	Slope
Preschool social competence	.16	−.29*	.05	−.31**	−.03	−.30*
Preschool intelligence	.04	−.29*	−.10	−.28*	−.08	−.37**
Verbal	−.17	−.19	−.22	−.10	−.27*	−.26*
Nonverbal	.17	−.28*	.00	−.32**	.05	−.31**
School intelligence	−.08	−.34**	−.16	−.24*	−.10	−.34**
Verbal	−.25*	−.28*	−.32**	−.03	−.27*	−.31**
Nonverbal	.14	−.31*	.06	−.39**	.11	−.27*

Note. $n = 68$ for stranger inhibition, $n = 71$ for class inhibition.
* $p < .05$. ** $p < .01$.

hibition in class, the reliabilities were .78 (level) and .41 (slope). Thus, level was assessed with a much higher reliability than slope. The findings of the next step of analysis suggested, however, that the reliability for slope was high enough for a significant prediction of slope from external variables.

The individual level and slope scores were related to three external variables: preschool social competence and preschool and school intelligence. Table 3 contains the correlations between these predictors and the individual level and slope parameters of the individual developmental functions for the two measures of inhibition toward strangers and for inhibition in class.

Table 3 indicates that all 21 correlations between the predictors and the slopes were negative, and 18 of them were significant. When level was partialed out in the slope for the judgmental measures of inhibition toward strangers, all correlations with the competence measures became slightly more negative. The three nonsignificant correlations involved verbal intelligence; thus, verbal IQ was not consistently related to the differential change in inhibition.

In contrast, verbal intelligence was the only predictor that showed significant (negative) correlations with the overall level of inhibition. Thus, the level of inhibition was negatively related to verbal IQ but not to nonverbal IQ or social competence, and inhibition showed increasingly negative associations with both nonverbal IQ and social competence, but not in every case with verbal IQ.

Extreme group analyses that contrasted the uppermost and lowest quartile and the middle half of the distribution of the slope scores with the upper and lower halves of the three competence measures fully corrobated the correlational findings. Among the children whose inhibition decreased most, those with high competence scores were overrepresented, and among the children whose inhibition decreased least, those with low IQ were overrepresented. For example, among the 17 children with the highest decrease in the observational measure of inhibition toward strangers, 11 had an above-average preschool IQ, and among the 17 children with the lowest decrease, 12 had a below-average IQ; the 34 children with nonextreme slope scores were split evenly into above- and below-IQ scorers.

Discussion

An analysis of children's individual developmental functions in observed inhibited behavior toward strangers and in teacher judgments of inhibition in school over a 6-year period between the beginning of preschool and age 10 showed that these functions could be approximated with some—though not high—reliability by linear functions. The slope of the functions was significantly negatively related to the children's nonverbal intelligence and social competence: The more competent a child was, the more the child's inhibition decreased over the 6-year period. This effect was replicated across two completely different types of assessment that reflected two different kinds of inhibition: observed inhibition toward strangers in the laboratory and teacher judgments of inhibition in class; the effect for inhibition toward strangers was found both for observer judgments of inhibition and for indexes of inhibited behavior. That the two kinds of inhibition were studied in only partially overlapping, though fairly representative, samples further increases the validity of the results. The consistency of the finding across different samples, settings, and measures is important because the reliability of the change scores was not high and the size of the effect was not large.

There are two plausible interpretations of this finding: a general and a pair of specific interpretations. The general interpretation is based on the a priori hypothesis derived from Sternberg's (1985) theory of intelligence that the more intelligent are generally better able to generate and automatize coping strategies for difficult social situations such as meeting strangers or facing peer neglect or rejection. Because these coping strategies were not directly assessed in the present study, this interpretation is not conclusive.

The more specific interpretations capitalize on particular consequences of intelligence in the two settings in which inhibition was observed. In elementary school, academic achievement is much more valued by the teachers than in preschool. Therefore, intelligent children who are better achievers may find it increasingly easier to interact with teachers than may less intelligent children. Because teacher judgments of children's

behavior with peers are also influenced by the behavior of the children in interactions with the teachers, teachers may increasingly tend to judge intelligent children as less inhibited independent of the children's behavior with classmates.

According to this alternative interpretation, the relation between competence and a differential decrease in inhibition is due to an increasing bias in the teacher judgments. Inhibition judgments by classmates and behavioral observations in the classroom or during recess outside the classroom are needed to rule out this interpretation.

A similar argument can be applied to the finding for inhibition in laboratory confrontations with adult strangers.[2] Most children in the present study visited the Max Planck Institute three times a year over the 6-year period for a 2-hr testing session that was always dominated by cognitive tests (inhibition is only one theme of the LOGIC study; other themes are memory and metamemory, mathematical ability, and causal reasoning). More intelligent children were more successful in these tests than were less intelligent children and therefore may have found the visits to Max Planck more enjoyable. They may have felt increasingly more relaxed compared with less intelligent children, even when they met an unfamiliar adult; they may have benefited from their perception of the situation as just another achievement-related setting.

A longitudinal study of children's inhibition toward strangers in a strictly nonacademic setting such as dyadic free play with an unfamiliar peer is required to rule out this second interpretation. Such dyadic play sessions were included in the LOGIC study but, unfortunately, only at the ages of 5, 7, and 8 years. An analysis of differential change in children's inhibition to an unfamiliar peer over this 3-year period did not produce significant relations with IQ or social competence. However, the age span covered may have been too short to detect a differential coping effect (the age span for inhibition toward adult strangers and for inhibition in class was twice as long).

The level of inhibition was negatively related to verbal but not to nonverbal intelligence, both for inhibition toward strangers and inhibition in class. Verbally more skillful children may find it somewhat easier to talk to strangers or in the classroom from an early age onward, whereas nonverbal intelligence was unrelated to the level of inhibition. That a similarly large discrepancy between verbal and nonverbal IQ was not found for the prediction of the slope scores further supports the view that the influence of competence on level and slope was due to different mediating processes.

In summary, this study has found that inhibition toward strangers and in class decreases more between preschool and age 10 for intellectually or socially more competent children than for less competent children. The most parsimonious interpretation of these data is that the more competent children with regard to intelligence and social competence are better able to develop successful coping strategies for difficult social situations. Future studies could try to test this hypothesis for social difficulties other than inhibiting situations.

At a more general level, the present study has demonstrated how Wohlwill's (1973) proposal for a study of individual developmental functions can be realized to answer questions of differential-developmental change in a typical longitudinal data set. Too often, such questions are only explored by the correlation of interindividual differences across age. I invite developmentalists who have access to longitudinal data sets with more than two waves to reanalyze their data from the perspective of individual developmental functions; such studies will make research in child development more developmental than it is today and will increase one's knowledge about the plasticity and malleability of interindividual differences.

[2] I am grateful to Marcel van Aken for proposing this argument.

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