# Assessing children's representations of their peer group using a multidimensional scaling technique

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ABSTRACT

The goal of this research was to examine whether multidimensional scaling (MDS) is a potentially reliable and valid method for assessing children's perceptions of their peer group. A total of 162 fourth- and fifth-grade students participated in two studies. MDS-derived depictions of the peer group were generated based on children's unconstrained (i.e., implicit) similarity judgments of same-sex dyads in their peer group. Overall, fit indices indicated that two-dimensional MDS solutions accounted for most of the variability in group members' similarity ratings, demonstrating considerable agreement between group members' implicit representations of their peer group. Furthermore, classroom teachers' perceptions of peer group organization were highly similar to their students' perceptions. Finally, the social network pattern in the peer group was related consistently to the organization of peer group members in the MDS similarity space; additional variance in the MDS space was accounted for by behavioral and nonbehavioral characteristics, most notably prosocial behavior. The results of this two-part study show the promise

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of using MDS methods to assess, and thus investigate, children's perceptions of their peer group's organizational structure. It was argued that implicit approaches to understanding children's perceptions of their peer group would be a useful addition to findings derived from the explicit methods typically employed in peer relations research.

KEY WORDS: children's peer groups • multidimensional scaling • social networks • social structure

Developmental theorists have hypothesized that the primary social task for children in the middle to late childhood period is learning to fit in with, and become accepted by, their peers (see review by Rubin, Bukowski, & Parker, 1998). Multiple factors influence the degree to which a child will be successful at mastering this developmental task. To some degree, fitting in with peers depends on a child's own characteristics, such as his or her behavioral characteristics (e.g., aggression, social withdrawal) and social problem-solving skills (Newcomb, Bukowski, & Pattee, 1993). Most peer relations research has focused on such individual-level characteristics (Cairns, Xie, & Leung, 1998). However, Hinde (1979) has noted that peer groups have their own characteristics and social dynamics (e.g., norms, hierarchical structure, and degree of cohesiveness), which also influence whether a child will become accepted within that particular group. For example, studies have shown the relation between aggression and social acceptance to vary, depending on the behavioral norms of the peer group (Stormshak, Bierman, Bruschi, Dodge, & Coie, 1999; Wright, Giammarino, & Parad, 1986).

One of the group-level characteristics that preadolescents seem to find important is the organizational structure of the peer group, including who holds which position within that structure (Gottman & Mettetal, 1986). Children this age spend a great deal of time and energy mapping their social environment and trying to reconcile their own social map with those of their friends (Parker & Gottman, 1989). Their interest appears to be driven partly by an acute awareness that a status hierarchy exists within the peer group (Gottman & Mettetal, 1986) and that they can be 'demoted' or 'promoted' for a wide range of reasons, not all of which are under their control (Parker & Gottman, 1989).

For preadolescents, an 'accurate,' up-to-date social map seems to be an invaluable tool for navigating the peer system. Developing methods capable of capturing children's social maps, in turn, could provide researchers with valuable insights into the peer system. For example, how do children represent their peer group's organizational structure and which criteria underlie that organization? Do children perceive their peers to be clustered into status groups (e.g., popular, rejected), organized according to social network patterns, and/or arrayed according to extracurricular interests (e.g., sports, music), behavioral (e.g., aggression) and personal (e.g., attractiveness, social class) characteristics, etc.? Can the particular

arrangement of peers within a child's social map tell us something about what is considered reputationally salient?

The current study emerged from a program of research interested in finding rigorous yet inductive methods for uncovering children's implicit representations of their peer group, the factors upon which those representations are based, and the significance of a child's placement within the group's organizational structure. The specific goal was to examine the reliability and validity of using multidimensional scaling (MDS) as an inductive tool for assessing children's perceptions of their peer group. In cognitive science, MDS models have been important in describing perceptual organizations, and in exploring the links among perceptual processes, learning, memory, and decision making (Ashby, 1992). Recently, the same models have been applied successfully to more complex social stimuli in the laboratory (e.g., Treat, McFall, Viken, & Kruschke, 2001). We believe that MDS methods also have great potential for exploring perceptual processes occurring outside the laboratory in natural social groups, particularly children's peer groups (Lease & Axelrod, 2001). In the sections that follow, a brief description of MDS methods is provided along with a rationale for using MDS to assess children's perceptions of their peer group.

## Multidimensional scaling (MDS): Brief overview

MDS (see Davison, 1983; Kruskal & Wish, 1978) is a descriptive statistical technique that can be used to 'uncover' the structure that individuals impose upon the objects, events, and situations in their environment (e.g., Nosofsky, 1986). The raw data for an MDS study consist of some type of similarity, or proximity, data: Each object within the set is paired with every other object, and for every pair, a judgment is made about how similar (or dissimilar) the two objects are to each other. When research participants are not given specific criteria for making these similarity judgments, and are allowed to choose their own criteria, then their similarity judgment is believed to be unconstrained and driven by the implicit criteria used by the participant (Jones & Koehly, 1993).

MDS uses these pairwise similarity judgments to construct a geometric representation of the set of objects. The geometric distances correspond to the psychological distances between the objects (Rudy & Merluzzi, 1984), so unlike other methods used to study groups (e.g., sociograms), the distance and orientation between objects is interpretable in the MDS space (Jones & Young, 1972). What that distance is based on, and why the objects are organized as they are in the MDS space, are the main questions of interest in an MDS study.

## Using MDS as an inductive tool to assess children's social representations

**Conceptual foundations.** MDS methods seem to be particularly well-suited to assessing children's internal representations of their peer group, because

the process of conducting an MDS study seems to be highly analogous to the process individuals naturally use to make sense of their social surroundings (Jones & Young, 1972).

First, each person is believed to have an internal representation of the social environment, which includes all of the individuals within that environment arranged in some meaningful pattern (Jones & Young, 1972). Those who are perceived to be alike in some fundamental way occupy similar positions within a person's representation, as in an MDS solution, whereas individuals who are perceived to be essentially different occupy positions that are farther apart. For example, in a fifth-grade boy's internal representation, athletic peers may be grouped together and distanced from nonathletic peers. However, the criteria used to create such a map might not be easily discernible to the outside observer, because such representations are believed to reflect subjective, experiential knowledge of events and others within that environment rather than the environment's 'objective' features (Jones & Young, 1972). Kelly (1955) has argued that individuals actively form representations of the social environment as a way to make sense of the world, to help predict the actions of others, and to choose among alternative courses of action.

Second, internal representations are believed to be constructed through a social comparison process (Jones & Young, 1972). Individuals tend to be judged in comparison to relevant others, like in a similarity judgment, rather than in relation to an absolute criterion. Thus, that same fifth-grade boy might judge a peer's athletic prowess by comparing him to his classmates, not a professional sports figure. In general, unlike younger children, who tend to compare behavior to absolute standards, older children have been shown to make more use of social comparisons in their judgments (Parke & Locke, 1999)

Third, both social comparisons and similarity judgments tend to be based on the 'gestalt' of those being compared (Lease & Axelrod, 2001). Both are based on a host of demographic, behavioral, personality, and interactional criteria (Jones, 1982), in addition to the perceiver's stereotypes and theories about how the world works (Wittenbrink, Hilton, & Gist, 1998).

Fourth, in real life, children compare, and judge, their peers based on criteria of their own choosing, depending on what is considered relevant and important. Likewise, in an unconstrained similarity task, children are not provided with explicit criteria for judging similarity, which allows MDS methods to be used to uncover implicit representations (Rudy & Merluzzi, 1984). Providing children with explicit criteria would subject them to researchers' a priori biases, beliefs, and assumptions (Jones, 1982). Although children can rate their peers reliably across a number of explicit, researcher-provided dimensions (e.g., aggression, likeability), that does not mean that those are the ones employed in their everyday social lives (Rudy & Merluzzi, 1984).

**Potential contributions of an MDS approach.** Inductive approaches to studying children's peer relations could be complementary to deductive

ones. Lease and Axelrod (2001) showed the potential value of including measures of social acceptance assessed with both approaches. Specifically, individual location within the MDS-derived organizational structure was included as an implicit indicator of acceptance (i.e., person–group 'fit'), whereas sociometric status (Coie, Dodge, & Coppotelli, 1982) was an explicit indicator. Results showed that the farther children were positioned from the center of the MDS space the less liked and more disliked they were. Peer-rejected (i.e., disliked) children located on the periphery of the MDS space were found to be even more disliked and to be less likely to have a reciprocated friendship than were peer-rejected students located more centrally in their peer group's MDS space. Further, peer-rejected students on the periphery also have been found to be more odd, more inattentive, more excluded, and more shy/anxious than peer-rejected students located more proximally to peers (Lease, McFall, & Viken, 2003). Lease and colleagues have speculated that including both indicators of social acceptance might be useful for identifying distinct 'types' of peer-rejected children.

MDS methods can be used as implicit tools, yet they do not rely on introspection and do not require a child to be 'conscious' of his or her construal of the social world (McFall, Treat, & Viken, 1998). And MDS methods are capable of assessing group-level attributes, long overlooked in the psychology-based peer relations literature (Cairns et al., 1998). Because MDS analyzes all dyadic similarity ratings simultaneously, the degree to which two children are rated as similar in the similarity ratings task will not equal the distance between those same two children in the MDS space. Thus, MDS reveals something about the configuration of the peer group – a group-level attribute – rather than the relation between dyads, or the dyad-level of the peer system (see Rubin et al., 1998).

### Studies 1 and 2: Overview

The aim of the current research was to examine whether MDS is a potentially reliable and valid method for assessing children's representations of their peer group's organizational structure, a group-level attribute. We also were interested in exploring what might underlie the particular arrangement of children in that organizational structure. In contrast, the Lease and Axelrod (2001) study was concerned with a child's distance from his or her peers in the MDS space, an individual-level attribute, and what that distance might indicate about that child's social developmental trajectory – not why children clustered as they did in the MDS space.

The first question was one of reliability: Can children complete a large number of similarity ratings in a reliable and consistent fashion, and can these be summarized adequately in the MDS output? Although children's ability to complete a large number of unconstrained similarity ratings reliably has been questioned (Collins, 1987), research evidence suggests that young children have this capability (e.g., Pedelty, Levine, & Shevell, 1985). However, the question was not only whether one child could produce an internally consistent set of similarity ratings, but also whether

the similarity ratings produced by a group of peers would evidence an adequate degree of inter-rater reliability. For example, in a peer group of 10 children, 10 matrices of similarity data are produced – one for each child. In a Replicated MDS (RMDS) analysis, used in this research, one model is fit simultaneously to all 10 matrices of data – not an 'average' of the data contained in the 10 matrices. To assess the adequacy of the model, MDS provides badness-of-fit or stress indices. Two factors can reduce the fit of the model: (i) poor internal consistency within matrices; and (ii) poor agreement, or inter-rater reliability, across matrices.

A second question addressed the convergent–discriminant characteristics of the MDS output. Basically, the aim was to use external data to try and explain what might underlie the arrangement of peer group members in the RMDS space. On the one hand, the arrangement of children in the RMDS output should be related to characteristics of children and peer groups shown to be important in peer relations research. On the other hand, RMDS also should have the potential to provide information about children's social functioning that is related to, yet distinct from, information provided by methods already available. However, the objective was to examine the validity of the MDS method and its output, not to attempt a thorough explanation of the RMDS output in each peer group. As noted previously, children could perceive the peer group to be organized around a broad array of factors. The group-level factors assessed included: (i) social status, determined by the number of times each child is nominated by the other group members as like-most and like-least (Coie et al., 1982); (ii) social network patterns, defined by the specific social links among the group's members (Cairns et al., 1998) and assessed using a modified version of the MDS approach advocated and demonstrated by Collins (1987); and (iii) out-of-school affiliation patterns. Individual-level factors assessed included: (i) personal characteristics, including attractiveness and social class standing; and (ii) a host of behavioral characteristics, including pro-social and aggressive behavior.

We also examined the correspondence between MDS solutions generated by children and those generated by their classroom teachers. Even though teachers are not peer group 'insiders,' they are daily observers of their students' social interactions. Thus, we might expect some correspondence between teachers' and group members' representations of the peer group. In general, concordance rates for teacher- and peer-rated constructs within the peer relations literature tend to be low to moderate: correlations indexing teacher–child agreement for social acceptance/peer popularity and classroom behavior items have tended to be anywhere from .24 to .59 (e.g., see McConnell & Odom, 1986).

In both studies, the peer group was defined as the set of same-sex children within a classroom. Peer interactions in the older elementary school grades mostly are segregated by gender: interactions with the opposite gender occur but are rare (e.g., Sroufe, Bennett, Englund, Urban, & Shulman, 1993) and friendships are primarily same-sex at this age (Maccoby, 1990).

# Study 1

## Method

### Participants

Participants were 92 fifth-grade students from five classrooms in a rural, Midwestern elementary school. Classrooms were self-contained, and most interactions during the school day took place with classmates. Forty-eight percent of the participants were female and all but one of the participants was Caucasian. The overall participation rate was 87%, with individual classrooms ranging from 79 to 92%. In one classroom, only boys participated, because the participation rate for girls would have fallen below 50%; their characteristics are unknown. Therefore, there were nine groups of children: five male and four female groups. The number of children per group ranged from 8 to 13.

### Procedure

Parental consent forms that included a place for parents to sign if they were granting consent were sent home with students in the spring of the school year. Parental consent and child assent were required for participation in the study. Only the names of the children with parental consent to participate were included on the measures used in the study. The measures that a participant completed were specific to his or her peer group (i.e., same-sex classmates).

Questionnaires were group administered and instructions for each measure were read aloud in the classroom by one of the researchers. Data collection lasted approximately 60 minutes per classroom. During data collection, nonparticipating classmates were asked to sit quietly at their desks and work on an activity of their choice. Teachers were asked to schedule sessions at a time immediately preceding a structured, academic activity; all children in the classroom were given a small gift as a way to thank the class for its time.

### Measures

**Similarity judgments.** The Ross ordering method (Ross, 1934) was used to construct the similarity judgment measure so that the presentation of names was balanced within dyads and throughout the measure (see Lease & Axelrod, 2001). To complete the measure, participants were instructed to think about what peer group members are like during the times when they are allowed to hang out and talk with each other during the school day (e.g., lunch and recess). Then participants were asked to rate – from 1 through 7 (1 = *very different*, 3 = *somewhat different*, 5 = *somewhat alike*, 7 = *very alike*) – 'how alike' (i.e., similar) they believed each pair of peers to be (e.g., 'how alike are Susan and Karen?'). No criteria for judging similarity were given. After reading the instructions and asking for questions, children completed the measure at their own pace. The number of similarity judgments a child completed ranged from 28 (8 children in a group) to 78 (13 children in a group). It is important to note that pairwise similarity judgments that included the child's own name were excluded from data entry.

**Social status.** Participants viewed a roster with the names of their participating classmates and were asked to nominate up to three same-sex classmates as like-most ('Who do you like the most?') and three same-sex classmates as like-least

('Who do you like the least?'; Coie et al., 1982). The numbers of like-most and like-least nominations participants received were summed and standardized, within group (i.e., class and sex), to a mean of 0 and an *SD* of 1. Construction of social preference (SP; like-most minus like-least) and social impact (SI; like-most + like-least) scores and assignment of social status group (i.e., popular, average, rejected, neglected, and controversial) were based on procedures developed by Coie and Dodge (1983).

**Social network patterns.** Like-most and like-least nominations also were used to summarize the specific pattern of in-school social affiliations (i.e., mutual-liking) evident within each peer group. First, the relationship between each pair of children, as indicated by their reciprocity in like-most and like-least nominations, was summarized for the classroom as a whole. Each dyad was given a score on a 4-point scale as follows: 1 = reciprocal like-least nominations; 2 = one child nominated the other as like-least; 3 = one child nominated the other as like-most; and 4 = reciprocal like-most nominations. No score was entered for pairs in which neither child nominated the other as like-most or like-least, or for pairs in which one child was nominated as like-least and the other as like-most (a very rare event). The 4-point scale used to create the mutual-liking variable is analogous to a similarity rating: The more two children like each other, the less 'distance' between them and the higher the score they received as a dyad.

Second, all pairwise, mutual-liking data points for each peer group were combined into one triangular matrix. The mutual-liking data contained in this triangular matrix were analyzed using a Classical MDS (CMDS; MDS analysis of only one matrix of similarity ratings) technique. The data for each peer group were analyzed separately, which resulted in one 2-dimensional 'mutual-liking' solution for each of the nine peer groups.

Children also rated the amount of out of school contact they have with their classmates (i.e., how much they 'play with the child after school and/or in the summer') on a 5-point scale (1 = *not at all*; 5 = *very much*). The data pertaining to these out-of-school affiliation patterns were contained in one rectangular matrix and analyzed using asymmetrical MDS (see Collins, 1987).

**Individual characteristics.** Children were asked to rate how well each of 22 behavioral descriptors described their peers. The presentation of positive and negative behaviors alternated. Each item was phrased according to the following format: 'Some children [behavioral descriptor]. How well does this describe: [list of classmates]?' Children were asked to indicate how well each behavior described their same-sex classmates on a 5-point scale (1 = *not at all*; 5 = *very much*). The variables included (alpha coefficients are reported when scores on conceptually similar descriptors were combined): (i) 8 verbal, physical, and relational aggression items (e.g., tease other kids and call them names; hit other kids and start fights for no good reason; when mad, they get even by keeping the person from being in their group of friends; $\alpha = .95$); (ii) 7 prosocial items (e.g., help others who are hurt, sick, or sad; good listeners with other children; $\alpha = .94$); (iii) good student (i.e., smart and do good work in class); (iv) athletic skills (i.e., good at most sports and games); and (v) 2 anxious/withdrawn items (e.g., act nervous or afraid to join in when other kids are playing or involved in activity; $\alpha = .76$). Teachers completed ratings of physical attractiveness and social class standing (i.e., come from educationally

and economically advantageous backgrounds compared to their classmates), using the same 5-point scale, because some school personnel believed that such constructs were too sensitive for peer-report.

## Results and discussion

### Fit of the MDS group solutions to the similarity data

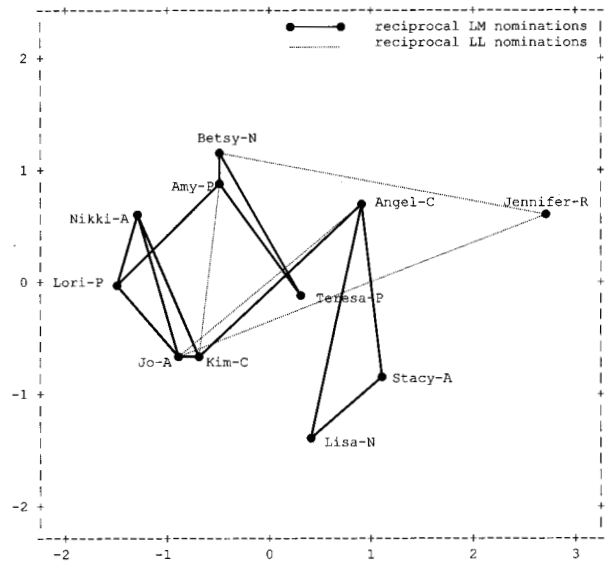
Can similarity ratings completed by different children in a group generate an adequate RMDS group solution? The similarity data for each of the nine peer groups were analyzed separately using PROC MDS available in version 6.07 of the SAS supplemental library. Within each group, all of the similarity matrices generated by the children in the group were analyzed simultaneously. RMDS analyses were used to fit an unweighted Euclidean distance model to ordinal level. Because the smallest group of children contained 8 members, a two-dimensional solution was generated for each of the nine groups. In general, the number of 'objects' needs to be adequate for the number of dimensions (i.e., approximately four 'objects' are needed for every dimension; Kruskal & Wish, 1978) in order to arrive at a valid interpretation of badness-of-fit values. The fit of each of the two-dimensional configurations to the similarity data was assessed with Stress 1, a badness-of-fit criterion (Kruskal & Wish, 1978). Badness-of-fit is analogous to the square root of $1 - R^2$, where '$R$ is a multiple correlation around the origin' (SAS Technical Report P-229, p. 259).

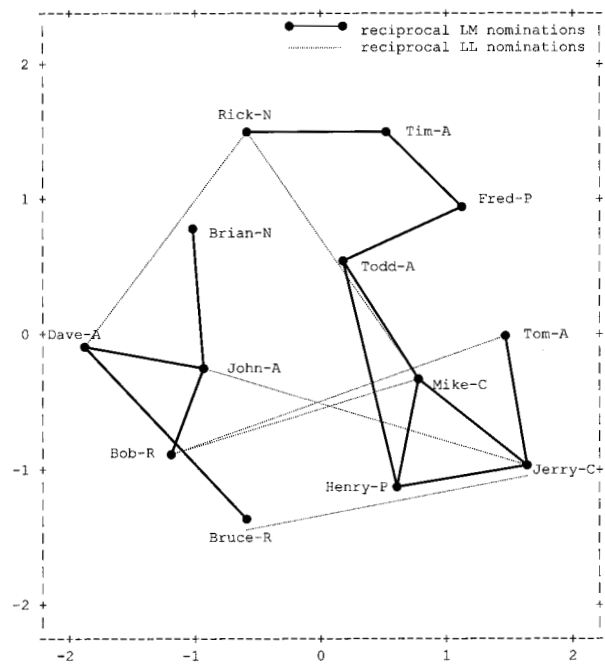
The mean badness-of-fit across the 9 two-dimensional solutions was .19. Thus, most of the variance in the similarity data (> 90%) was accounted for by the RMDS solutions, which is high considering that the RMDS models were fit simultaneously to a series of replicate matrices (e.g., 10 in a 10-person group). Badness-of-fit was somewhat higher than in a typical cognitive science experiment in which college students rate the similarity of simple, artificial stimuli (e.g., height and width of a series of rectangles). However, our fit values are comparable to those reported in MDS studies using real-life stimuli (e.g., Treat et al., 2001). To further assess the fit values, we generated and then analyzed simulated random data that were directly comparable to the data in our study. We simulated a 'typical' analysis situation, in which 10 children rated the similarity of all possible pairs of 10 peers; 15 such sets were generated. Each matrix value was a random sample from a uniform distribution in the interval (0, 10). An RMDS model then was fit to each of the simulated datasets. The average S-stress value was .50 and the average stress value was .38. Those values indicate a markedly worse fit than observed in our study (i.e., .19), which reflects the influence of systematic processes (i.e., perceptual processes shared across peer group members) in our data.

### Descriptive overview of the RMDS similarity spaces

For descriptive purposes, RMDS similarity spaces for two representative groups of children, one female and one male, are presented in Figures 1a and 1b. As illustrated, pairs of children with reciprocal like-most nominations seemed to be closer in the RMDS spaces (i.e., judged as more similar) than other pairs; in contrast, children with reciprocal like-least nominations were quite distant (i.e., judged as less similar). Children did not appear to cluster within the RMDS space according to social status groups (e.g., popular, rejected).

**FIGURE 1 (a, b)**
**Examples of RMDS-derived depictions of peer group organizational structure – with names of participants changed – with mutual-liking patterns (partial) and social status groups (i.e., average, popular, rejected, neglected, controversial) indicated.**



Similar to Lease and Axelrod (2001), several of the RMDS group spaces were observed to contain a peer group 'outlier,' such as 'Jennifer' (Figure 1a). Outliers were not close to any peers in the RMDS space. They were seen as quite dissimilar from their peers and on the periphery of the group's organizational structure (see Lease & Axelrod, 2001). They seem to match traditional conceptions of the 'rejected' child, as well as intuitive notions of the social outcast. However, not all rejected children, as defined by the Coie and Dodge (1983) system, seemed to fit this image of outlier. In fact, Lease and Axelrod reported that rejected outliers within the RMDS space were less well-liked and less likely to have a mutual friend than rejected children who were not outliers within the RMDS space. Similarly, Parker and Asher (1993) reported that not all rejected children are friendless, further supporting the notion that differing kinds of peer-rejected children exist.

### Relation of group-level variables to the RMDS similarity space

Do the social characteristics (i.e., social status, mutual-liking, out-of-school affiliations) of peer groups relate to perceptions of the peer group's organizational structure? In addressing this question, it is important to note that the RMDS and social network (i.e., mutual-liking and out-of-school affiliations) spaces were generated using data from distinct sources (e.g., similarity data vs. sociometric nomination data). Furthermore, the RMDS similarity space reflects peer-report – not children's judgments of their own similarity to others, because those ratings were excluded from data entry. In contrast, the social network spaces summarize self-reports of playmate preferences – not peer judgments of other children's playmate preferences.

A 'distance' approach was chosen for data analysis. The goal was to relate the (Euclidean) distance, or similarity, between children in the RMDS space to their distance within the social network. To this end, we used the Distance Macro (SAS supplemental library) to calculate the distance between (i) all pairs of children in the RMDS-derived organizational structure and again in the (ii) CMDS-derived mutual-liking space and (iii) asymmetrical MDS-derived out-of-school social network.

Simple regressions of the vector of dyadic mutual-liking distances onto the vector of dyadic RMDS distances were computed (Table 1). The magnitude of the $R^2$s suggests that mutual-liking is descriptive of group organizational position. (Significance levels associated with inferential statistics can be biased when applied to structured data like those in RMDS configurations, so a criterion $R^2$ of .20 was arbitrarily chosen.) Overall, mutual-liking distance accounted for 20–48% of the variability in RMDS space distance in all but 2 of the 9 groups of children, which suggests that mutual-liking patterns are a major criterion underlying children's internal representations of their peer group's organizational structure. Furthermore, mutual-liking appears to be a fairly consistent predictor of positioning across peer groups, given the substantial relation between mutual-liking and RMDS space distances in 7 of 9 peer groups. Simple regressions of the vector of dyadic out-of-school affiliation distances onto the vector of dyadic RMDS distances showed that out-of-school interaction patterns also were predictive of spacing in over half of the RMDS spaces ($R^2 > .15$ in 5 groups). Not surprisingly, in-school affiliation patterns were more consistently predictive than out-of-school affiliations of the organizational structure of classroom-based peer groups.

Next, we assessed the relation between social status measures and the RMDS

**TABLE 1**
**Regressions on group-level variable distances by RMDS space distances: Study 1**

| | | Mutual-liking | | Social preference/impact | | Out-of-school | |
|---|---|---|---|---|---|---|---|
| Group | $n^a$ | $R^2$ | β | $R^2$ | β | $R^2$ | β |
| 1 | 45 | .29 | .54 | .03 | .18 | .26 | .51 |
| 2 | 55 | .08 | .29 | .03 | .19 | .02 | .14 |
| 3 | 28 | .48 | .69 | .20 | .45 | .16 | .40 |
| 4 | 55 | .30 | .55 | .01 | .05 | .15 | .39 |
| 5 | 36 | .45 | .67 | .10 | .32 | .07 | .27 |
| 6 | 55 | .29 | .54 | .11 | .34 | .13 | .36 |
| 7 | 28 | .23 | .48 | .27 | –.52 | .16 | .40 |
| 8 | 55 | .16 | .39 | .35 | .59 | .15 | .39 |
| 9 | 78 | .35 | .59 | .05 | .23 | .14 | .38 |

[a]Number of pairs of children in the group.

space. Coie and colleagues (Coie et al., 1982) have suggested that children's peer groups are ordered along two orthogonal dimensions: social preference and social impact. Furthermore, those two dimensions are believed to create clusters of children, according to their social status within the peer group (i.e., popular and rejected children anchor the ends of the social preference dimension; neglected and controversial children anchor the ends of the social impact dimension).

Do the dimensions of social preference and social impact underlie the arrangement of children in the RMDS space? We calculated the distance (Distance Macro) between dyads with regard to their social preference and social impact scores. A dyad of popular children, for example, should have a fairly low preference/impact distance score, whereas a dyad comprised of one popular and one rejected child should have a higher distance score. Computing simple regressions, composite social preference/social impact distance was positively related to RMDS similarity distance for only 2 of the 9 groups. Consistent with earlier visual inspection, these results indicated that social status was not a consistent factor underlying children's perceptions of their peer group, as children were not arranged consistently by social status dimensions.

## The relation of individual characteristics to RMDS positioning

In the next set of analyses, we examined whether the organization of children in the RMDS spaces was related to behavioral, personal, and demographic variables (Table 2). Distances between pairs of children were computed (Distance Macro) for each variable (e.g., how similar was each dyad with regard to their rated levels of aggression?). Peer-rated prosocial behavior was the most consistent predictor of distance between dyads in the RMDS space (i.e., $R^2 > .20$ in 7 groups), followed by peer-rated aggression for boys ($R^2 > .20$ in 4 of 5 male groups). Thus, prosocial behavior appeared to be a fairly consistent criterion for determining how children of both sexes are grouped in the collective social map of their peer groups; aggressive behavior was a consistently used criterion for boys. The sample was attenuated in terms of social class standing, which may be related to positioning in more heterogeneous samples. Overall, in all but two groups of children, at least one of the

**TABLE 2**
**Regressions on mutual-liking and individual-level variable distances by RMDS distances: Study 1**

| | Behavior | | Behavior + Mutual-Liking (ML) | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Beh | | ML | |
| Group | $R^2$ | β | $R^2$ | β | *SE* β | β | *SE* β |
| **Male groups** | | | | | | | |
| 1 (ML $R^2$ = .29) | | | | | | | |
| prosocial-P | .25 | .50 | .50 | .45 | .07 | .50 | .11 |
| athletic-P | .27 | .52 | .44 | .42 | .24 | .40 | .12 |
| aggressive-P | .28 | .53 | .48 | .44 | .06 | .46 | .12 |
| 3 (ML $R^2$ = .48) | | | | | | | |
| prosocial-P | .38 | .62 | .66 | .44 | .09 | .55 | .10 |
| smart-P | .28 | .53 | .63 | .40 | .13 | .61 | .10 |
| aggressive-P | .31 | .56 | .49 | .12 | .17 | .60 | .17 |
| 5 (ML $R^2$ = .45) | | | | | | | |
| prosocial-P | .42 | .65 | .74 | .54 | .05 | .57 | .08 |
| smart-P | .22 | .47 | .65 | .46 | .10 | .65 | .10 |
| aggressive-P | .35 | .59 | .65 | .46 | .05 | .56 | .10 |
| 7 (ML $R^2$ = .23) | | | | | | | |
| smart-P | .18 | .42 | .34 | .34 | .60 | .41 | .14 |
| 9 (ML $R^2$ = .35) | | | | | | | |
| prosocial-P | .26 | .51 | .46 | .48 | .08 | .36 | .06 |
| smart-P | .22 | .47 | .43 | .31 | .08 | .49 | .08 |
| athletic-P | .16 | .40 | .41 | .26 | .13 | .52 | .08 |
| aggressive-P | .24 | .48 | .44 | .30 | .06 | .48 | .08 |
| **Female groups** | | | | | | | |
| 2 (ML $R^2$ = .08) | | | | | | | |
| prosocial-P | .21 | .46 | .26 | .42 | .09 | .22 | .12 |
| 4 (ML $R^2$ = .30) | | | | | | | |
| prosocial-P | .25 | .50 | .45 | .39 | .09 | .46 | .09 |
| athletic-P | .23 | .48 | .41 | .35 | .14 | .45 | .10 |
| anxious-P | .25 | .50 | .41 | .35 | .16 | .43 | .10 |
| social class-T | .15 | .39 | .38 | .28 | .10 | .49 | .10 |
| 6 (ML $R^2$ = .29) | | | | | | | |
| prosocial-P | .15 | .39 | .36 | .26 | .07 | .47 | .10 |
| athletic-P | .16 | .41 | .36 | .26 | .20 | .46 | .11 |
| attractiveness-T | .17 | .41 | .33 | .22 | .10 | .45 | .11 |
| 8 (ML $R^2$ = .16) | | | | | | | |
| prosocial-P | .35 | .59 | .46 | .55 | .06 | .33 | .11 |
| smart-P | .18 | .43 | .31 | .40 | .15 | .36 | .12 |
| athletic-P | .32 | .57 | .36 | .49 | .17 | .21 | .13 |
| anxious-P | .32 | .56 | .42 | .52 | .11 | .33 | .11 |
| aggressive-P | .20 | .45 | .37 | .47 | .08 | .41 | .12 |

*Notes*. Results of simple regressions appear in columns 1–2; results of multiple regressions appear in columns 3–7 (β = standardized regression coefficient). In the interest of space, only individual characteristics that were substantial predictors ($R^2 \geq .15$) of positioning in the RMDS space were included in the table. The total $R^2$ refers to the total amount of variance accounted for in similarity space distance by mutual liking and each respective individual characteristic distance, rather than a cumulative total of all individual variables plus mutual liking. P = Peer assessed characteristic; T = teacher assessed characteristic.
Number of pairs of children in each group: 1 = 45, 2 = 55, 3 = 28, 4 = 55, 5 = 36, 6 = 55, 7 = 28, 8 = 55, and 9 = 78.

behavioral or background characteristics accounted for at least 20% of the variability in children's placement within the RMDS space. Thus, the placement of children in the RMDS spaces appears to be related to individual characteristics in addition to social network patterns. However, the topography of each group appeared to be distinct as well: a unique combination of characteristics was related to each space.

A follow-up set of multiple regressions was computed to examine whether individual characteristics would be predictive of distance in the RMDS space, even when the mutual liking variable was included as a predictor. Research has shown that children tend to affiliate with behaviorally and demographically similar peers (e.g., Cairns, Cairns, Neckerman, Gest, & Gariepy, 1988; Kupersmidt, DeRosier, & Patterson, 1995; Poulin et al., 1997). In most groups, at least one individual characteristic accounted for at least 10% more of the variance in RMDS space distances even with the mutual liking variable in the equation. Prosocial behavior, in particular, continued to be a consistent predictor across groups. Of the 7 groups with a substantial univariate relation between prosocial behavior and the RMDS similarity space ($R^2 > .20$), prosocial behavior continued to account for at least 15% of the variability in positioning in 6 groups. Thus, prosocial behavior appeared to be the most consistent behavioral criterion children in our sample used to compare their peers, and this relation tended to remain even when mutual liking was included as a predictor. In the 5 groups where aggression was a substantial predictor in univariate equations, the relation dropped out in 2 groups ($R^2 < 10\%$) after mutual liking was entered into the equation.

## Study 2

The primary goal of Study 2 was to examine the external validity of the RMDS solutions. Specifically, a fresh sample of teachers and their students performed the same similarity rating task as in Study 1, and then we compared the similarity of child and teacher social representations.

### Method

#### Participants

Participants were 70 fourth- and fifth-grade children (71% female; all Caucasian) from five classrooms in a rural Midwestern school district. Again, classrooms were self-contained throughout the school day. Participants came from one of seven homogeneous peer groups, each consisting of the same-sex peers from each classroom (5 female groups; 2 male groups). The number of student participants per group ranged from 9 to 12. Five teachers also participated with consent. The mean participant rate for a peer group was 86% (ranging from 79 to 92%); the same consent/assent procedure was followed as in Study 1.

#### Procedure

Data were collected in two parts. First, teachers and students provided pairwise similarity ratings for the participating same-sex students in their classrooms: teachers were given the same instructions as their students for completing the similarity judgment task (i.e., how alike are the children in each pair?). After

**TABLE 3**
**Regressions on teacher-rated CMDS distances by child-rated RMDS distances: Study 2**

| Group | $n^a$ | $R^2$ | β |
|---|---|---|---|
| 1 | 36 | .41 | .64 |
| 2 | 55 | .41 | .64 |
| 3 | 66 | .26 | .51 |
| 4 | 36 | .55 | .74 |
| 5 | 36 | .28 | .53 |
| 6 | 45 | .60 | .77 |
| 7 | 45 | .42 | .65 |

[a] Number of pairs of children in the group.

the rating task, students completed social status nominations for members of their group. Measures were group-administered to students, and took approximately 20 minutes per classroom. Teachers completed the similarity rating task at the same time as their students.

Again, student participants completed only sex-congruent versions of the similarity and social status measures. Like-most and like-least nominations were used to construct the mutual-liking variable. The procedure followed was the same as in Study 1, except that the number of similarity judgments ranged from 36 (9 children in the group) to 66 (12 children in the group).

## Results

### Fit of the RMDS group solutions to similarity ratings

For the student-generated RMDS spaces, the median badness-of-fit across the two-dimensional solutions for the seven groups was .17. Teachers' similarity ratings for each of the seven student groups were analyzed in essentially the same manner as described in Study 1. However, because only one teacher completed similarity ratings for each peer group, these data were analyzed using CMDS. The median badness-of-fit across the CMDS solutions was .04.

### Correspondence between students' and teachers' perceptions

A comparison was made of the distances between dyads in each student-generated RMDS solution and the corresponding teacher-generated CMDS solution. The results of regressing the vector of CMDS distances onto the vector of RMDS distances are summarized in Table 3. Across the seven peer groups, distances between dyads in teachers' similarity spaces accounted for 25 to 60% of the variance in dyadic distances in the corresponding similarity spaces generated by students. The typical, or median, $R^2$ was .41, indicating a reasonably good correspondence between MDS-depictions of teacher and student social representations, especially given that unconstrained similarity judgments were used to derive them. In fact, the correspondence between teacher- and child-derived similarity spaces compares favorably with the typical rates of teacher–child agreement in the peer relations literature (i.e., *r*s ranging from .24 to .59), as noted earlier.

**TABLE 4**
**Regressions on distances in the teacher-generated and child-generated MDS spaces by mutual-liking and social status distances: Study 2**

| Peer group | $n$[a] | Internal representations of organizational structure: Teacher-generated $R^2$ | Teacher-generated β | Child-generated $R^2$ | Child-generated β |
|---|---|---|---|---|---|
| 1 | 36 | | | | |
| | Mutual-liking | .08 | .28 | .12 | .35 |
| | Social status | .51 | .71 | .47 | .69 |
| 2 | 55 | | | | |
| | Mutual-liking | .25 | .50 | .47 | .69 |
| | Social status | .07 | .27 | .00 | .03 |
| 3 | 66 | | | | |
| | Mutual-liking | .09 | .30 | .36 | .60 |
| | Social status | .00 | .00 | .10 | .31 |
| 4 | 36 | | | | |
| | Mutual-liking | .07 | .27 | .22 | .47 |
| | Social status | .34 | .59 | .33 | .58 |
| 5 | 36 | | | | |
| | Mutual-liking | .28 | .53 | .44 | .66 |
| | Social status | .19 | .44 | .23 | .48 |
| 6 | 45 | | | | |
| | Mutual-liking | .47 | .68 | .65 | .81 |
| | Social status | .05 | .22 | .01 | .12 |
| 7 | 45 | | | | |
| | Mutual-liking | .24 | .49 | .42 | .65 |
| | Social status | .02 | .15 | .01 | .07 |

[a] Number of pairs of children in the group.

### Relation of mutual-liking and social status indices to teacher- and child-generated MDS spaces

Euclidean distances between all pairs of children in each of the mutual-liking solutions were calculated and regressed, in turn, onto the CMDS distances and onto the RMDS distances (see Table 4). With regard to teacher representations, mutual-liking distance accounted for 7–47% of the variability in the corresponding CMDS solutions across the seven groups of children, with a median $R^2$ of .24. For three of the seven groups of children, mutual-liking was not a particularly strong predictor of placement within the corresponding teacher's internal representation of the peer group (i.e., $.07 < R^2 < .10$), casting doubt on its reliability as a predictor of teachers' perceptions. In terms of the child-generated RMDS solutions, mutual-liking distances accounted for 12–65% of the variability in the corresponding RMDS solutions, with a median $R^2$ of .42. This latter result is similar to, although stronger than, that obtained in Study 1; with $R^2 > .20$ for six of seven groups, it again suggests that mutual-liking is a reliable predictor of children's social representations of the peer group.

Across the seven groups, social status distance accounted for 0–50% of the variance in teachers' CMDS-derived representations (median $R^2$ = .07). Similarly, social status distance accounted for 0–47% of the variance in the child-generated RMDS space (median $R^2$ = .10). The relation between social status distance and distance in the organizational structure tended to be very inconsistent, for students ($R^2$ = .20 for only 3 of 7 peer groups) and teachers alike ($R^2$ = .20 for only 2 of 7 peer groups and almost for a third). However, Table 4 showed that if a student group showed a strong association, so did the teacher; if the student group showed a weak association, the teacher did too. That pattern suggests that any observed relationship, or lack thereof, between social status and the MDS space for a particular group probably is not due to chance alone. Table 4 also demonstrated that the values for mutual-liking were higher than for social status in five of seven groups for both students and teachers, and always in the same pattern.

## General discussion

The primary conclusion to be drawn from this study is that RMDS appears to be a reliable and valid tool for assessing a peer group's organizational structure, as perceived by its members. Specifically, the badness-of-fit values indicated that: (i) children produced an internally consistent set of similarity judgments, and (ii) the sets of similarity judgments produced across children within each peer group were highly similar. Most of the variability in similarity ratings was accounted for by one RMDS solution per peer group. Thus, an analytical strategy that 'forced' the same perceptual space on all members of the peer group was able to explain most of the variance in similarity ratings, showing that children do not hold idiosyncratic representations of the peer group. Consistent with these results, others have argued that to the extent that children from the same peer culture experience similar, if not identical, types of social interactions, they should develop a shared perception of their group's organizational structure (e.g., Corsaro, 1992). Furthermore, children actively engage their friends in conversations to try and make sense of their social experiences, which should serve to further consolidate their perceptions (Parker & Gottman, 1989).

With regard to the validity of the information in the RMDS space, results showed that classroom teachers held a view of the peer group's organization that was similar to their students' collective social representation, further suggesting that the criteria used to judge similarity were not only important but also salient to those in daily contact with the peer group. Furthermore, the results showed that the arrangement of children in the RMDS-derived social map was related to socially relevant, external data.

A second conclusion is that children's social maps contained information about the group's attributes as well as the individual characteristics of its members. In particular, social network patterns appeared to be a major factor underlying children's social maps of the peer group. Specifically, results showed that the arrangement of peer group members within the

RMDS space was related substantially (i.e., $R^2 \geq .20$) and consistently (i.e., in 13 of 16 groups) to the group's mutual-liking patterns. Because analyses of similarity ratings did not include children's ratings of their own similarity to peers, beliefs about how similar one is to one's own friends, and how different one is from disliked peers, did not influence the observed relation between mutual-liking patterns and the perceived organizational structure. Rather, children apparently believe that when children spend a great deal of time together, as friends tend to do, they share important characteristics in common. In fact, research has shown friends to be similar across a range of demographic characteristics as well as peer-rated behavior (e.g., Kupersmidt et al., 1995), consistent with the similarity–attraction hypothesis whereby individuals are attracted to, and more likely to become friends with, those who are similar to themselves (Byrne & Nelson, 1965).

The mutual-liking results suggest that the pattern of alliances among peers is an essential piece of information for making sense of the social environment, predicting how peers will act, and deciding on the 'best' course of action for oneself. For example, 'who is allied with whom against whom and what are the implications of me taking one side over the other?' However, the results also indicated that, in addition to the particular mutual-liking patterns in the group, children consider the behavioral and personal characteristics of their peers when mapping the peer group. Consistent with person–group similarity research (e.g., Wright et al., 1986), peer groups mostly varied with regard to which particular individual characteristics were reputationally salient, with the exception of prosocial behavior. It appears that the degree to which peers possessed prosocial characteristics was consistently important to the 4th–5th grade children in the current study.

A third conclusion is that sociometric status dimensions – social preference and social impact – did not appear to underlie children's perceptions of their peer group's organizational structure. On the surface, the results appear to differ from those reported by Lease and Axelrod (2001), who reported that sociometric measures were related to an individual's placement in the RMDS space. In the latter study, children's relative likeability was related to their perceived distance from peers in the social map. For example, Lease and Axelrod showed that the majority of those on the periphery of the RMDS space were peer-rejected. The current results indicated that children were not arranged in the RMDS space along the two sociometric dimensions, or clustered according to their status subtype. For example, two peer-rejected children might lie on the periphery of the RMDS space yet not be anywhere near each other. Taken together, the two sets of findings indicate that, while disliked children are more likely to be perceived as distanced (i.e., dissimilar) from others in the organizational structure than are better liked children, those who are of the same sociometric status are not necessarily perceived as similar to each other either. This makes sense, given that a child can arrive at a given social status for a variety of behavioral and even nonbehavioral reasons (Coie, 1990). For example, the peer-rejected subtype is behaviorally diverse, with some

rejected children being primarily aggressive and some being primarily withdrawn (e.g., French, 1988). Children would not necessarily judge two rejected peers to be similar if those two children had vastly different behavioral profiles (e.g., aggressive vs. withdrawn), even if they were both disliked by peers.

In a few peer groups, the two sociometric status dimensions did underlie the arrangement of children in the RMDS space; furthermore, mutual-liking was not related in a substantial way to the RMDS space of a few peer groups. Although it is not clear why this might have occurred, future study of groups that deviated from the norm could be illuminating. In general, however, the results indicated that when trying to navigate the peer system – and to predict how a given social situation might unfold – children seem to find it more useful to consider how the involved parties have behaved in past situations, as well as the pattern of alliances among the 'players,' than how well-liked their peers are by the peer group as a whole.

### Limitations and future directions

The two studies reported here were conducted with racially and socio-economically homogeneous, same-sex peer groups in the latter half of elementary school, which limits the generalizability of the results. The method used to create the social network variable used in this study is another potential limitation. The mutual liking variable was created using an MDS approach, although many approaches have been developed to derive social networks (see Cairns et al., 1998). It has been suggested that describing the total social environment, with regard to how each person in the peer group is connected to each other person, may not be entirely appropriate if the goal is merely to describe the exact set of peers with whom a child is affiliated (Kindermann, 1998).

Despite these limitations, the results of the current research highlight the potential contribution of MDS methods to the study of children's peer groups. First, MDS, as an implicit method of inquiry, could be used to discover which group-level and individual-level factors are of implicit reputational salience in diverse contexts (e.g., urban vs. rural), to children of various ages, and across differing demographic groups (e.g., boys vs. girls). Furthermore, developmental trends in the degree to which demographic factors, such as ethnicity, gender, and socio-economic status, are salient factors underlying children's perceptions of how the peer group is structured could be examined and related to children's attitudinal characteristics and interactional patterns. For example, Roberts, Musgrove, and Lease (2002) reported that the mean distance in the RMDS space between dyads of same-race friends was less than the mean distance between dyads of cross-race friends. Does the degree to which peer groups vary in this regard predict the racial attitudes and behaviors of its group members? In general, can the quality of race relations within a peer group be predicted based on the degree to which race underlies the group's perceptual organization?

Second, shifts in friendship patterns might be predictable from children's placement within the RMDS space. For example, Davison and Jones (1976)

used MDS to assess the perceived organizational structure of an academic group comprised of staff, faculty, and graduate students. That specific placement of the group's members was used successfully to predict the frequency and pattern of future social and professional interactions, such as service on dissertation committees and patterns of research collaborations. Similarly, it would be interesting to see whether the proximity between children within the RMDS space is predictive of which dyads will form a friendship, or, conversely, which friendship dyads are most likely to dissolve.

Third, individual differences in children's social maps could be assessed. Specifically, Weighted MDS (WMDS) is designed to uncover group perceptions, like RMDS, but WMDS also quantifies individual differences in those perceptions. Individual differences are likely to exist. Some type of social difficulty would be predicted for children whose perceptions are largely discrepant from those of their peers (Ingram & Kendall, 1986), if indeed children's internal representations help them make social decisions (Jones, 1982). Faulty social perceptions are likely to lead to poor social decision-making, a link that could be tested. In fact, basic research in cognitive science has demonstrated how the information in MDS solutions can be used to predict other cognitive processes, including decision making (e.g., Ashby, 1992). Other studies could be conducted to examine the role various factors play in the establishment of individual differences, such as differential access to social events, interactions with 'key' players in the peer group, information-processing factors, etc.

These are just a few of the questions that might be addressed by using MDS to study children's perceptions of their peer group, in addition to those concerning a child's position within the RMDS space and the implications for his or her social developmental trajectory (Lease & Axelrod, 2001; Lease et al., 2003). The current research supported the feasibility of using MDS methods with children, but it remains for future studies to examine in more detail the descriptive and predictive utility of these new methods.

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