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Clique Analysis of Interpersonal Interactions: Grouping Patterns in a Supported Employment Work Setting

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Clique Analysis is used to analyze interactions observed at a supported employment setting in which seven nondisabled persons work alongside eight persons considered severely disabled and supervised by a human service supervisor. The analysis depicts social structures and grouping patterns reflecting the levels of social integration at the work site. Information from the analysis suggests that employees with disabilities were neither fully integrated nor fully segregated, but engaged in different states of interaction between the two extremes.

The quantitative study of social networks is useful in revealing the patterns in which individuals form groups. Descriptions of basic social network concepts are available from many sources (e.g., Knoke & Kuklinsky, 1982; Mitchell, 1969). Usually, a social network showing a given type of interaction among a group of persons is graphically depicted by a number of points connected by lines. Each point is called a "node," representing a person. Each line is called a "connection," representing the interaction between two persons. For some directional interactions such as smiling at someone, or helping another individual, the connections will have arrows showing who provides and who receives the interaction. Each connection is also associated with a value between 0 and 1 obtained by scaling the observed frequency or duration of the interaction. This value is called "strength" and depicts how long or how frequent the interaction is. A con-

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nection with a measured strength of 0 shows no interaction and is not depicted; a connection with a strength of 1 can be viewed as a strongest connection relative to other connections in the same network. The hypothetical network in Figure 1(a) is constructed to reflect the help-providing interactions among eight persons which are directional. Figure 1(b) shows a hypothetical interaction of conversation among the same eight persons; because conversation is a two-way interaction by nature, the network is not directional.

The notion of a clique in a social network was first suggested by Luce and Perry (1949). Since then, many researchers (Alba, 1973; Doreian, 1974; Peay, 1974; Seidman & Foster, 1978; Yan, 1988a) have further developed this notion and improved the clique detection algorithm.

Clique analysis has been applied to study social relationships among individuals. Using clique analysis, Hubbell (1965) analyzed relations among 67 prisoners in a correction institute. Laumann and Pappi (1976) investigated networks among the social elites within a small German city.

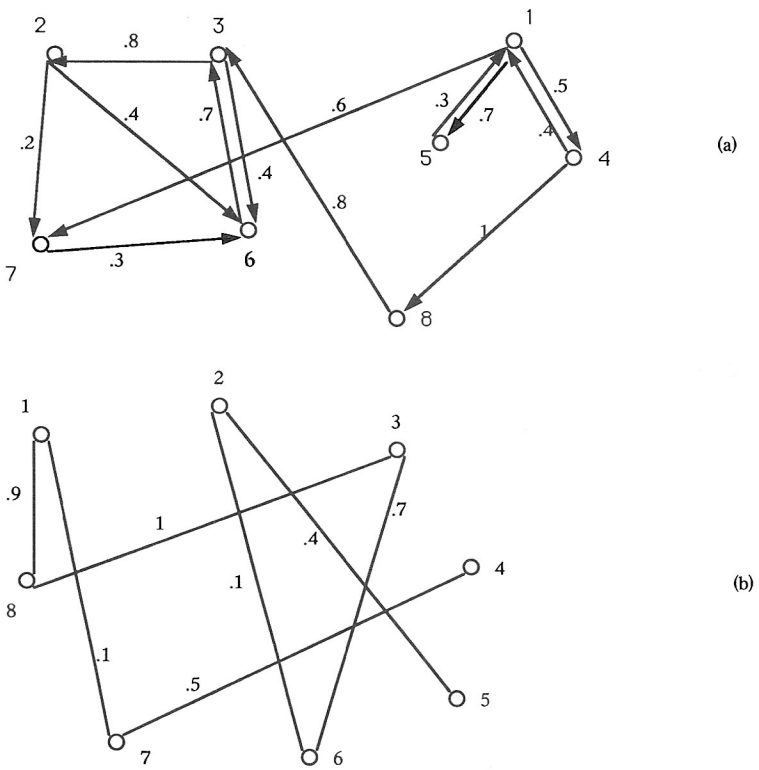

FIG. 1. Examples of social networks.

Seidman and Foster (1978) studied the control relationship in a Tai village. Yee (1980) described the relationship of who-likes-whom among 21 students in a classroom. Doreian (1988) used clique analysis to study the support relationship among 14 prominent politicians of a Midwestern county. Yan (1988a) investigated help-seeking among researchers in a university research institute. The reader can find a basic description of clique research in Knoke and Kuklinsky (1982) and a detailed description of the evolution of clique analysis and the formal definitions of clique concepts in Yan (1988a).

Although the concept of a clique has evolved, the basic idea that a clique is a "highly cohesive subset of actors within a network" (Knoke & Kuklinsky, 1982, p. 56) has not changed. In this paper, the term "clique" means a group of individuals in which each member is connected directly or indirectly to all others through interactions. If the interaction is directional (e.g., interactions involving giving instructions to another), each member has to connect to every other clique member in both directions (e.g., clique members give instructions to each other directly or indirectly or through other members). Two cliques and one outside node (i.e., an individual who belongs to no cliques) are found in Figure 1(a) based on this definition. One clique is found in Figure 1(b). These cliques are represented with circles in Figure 2.

In a typical network, there can be too many connections inside a clique to allow a clear display. Connections inside a clique can be omitted because every pair of that clique's members is already known to be connected directly or indirectly by definition. When the research interest is to identify clique members, the strength of connections between clique members and outside nodes can also be omitted to enhance visual clarity. In Figure 3, we revise the display of the cliques in Figure 2 in this way.

"Cutting" a network using a number between 0 and 1, say 0.4, means revising the original network by deleting all the connections with strength less than 0.4. Cliques found in the revised network are called cliques with a detection level of 0.4. By gradually changing the detection level from 1 to 0 and showing the cliques with different levels, the interactors' degrees of social involvement can be revealed and compared. Interactors included in cliques at higher levels are more involved in interactions than those included only in cliques at lower levels. Figure 4 shows the cliques found at two different levels in networks displayed in Figure 3.

A detailed explanation of the mathematics of clique analysis is beyond the scope of this paper. However, a description of all the major steps and computations for conducting the analysis is given below.

Step 1. Collecting data and establishing the network. In this step, the interaction and persons involved as nodes are specified. Frequencies and directions of the interaction between each pair of nodes during a period of

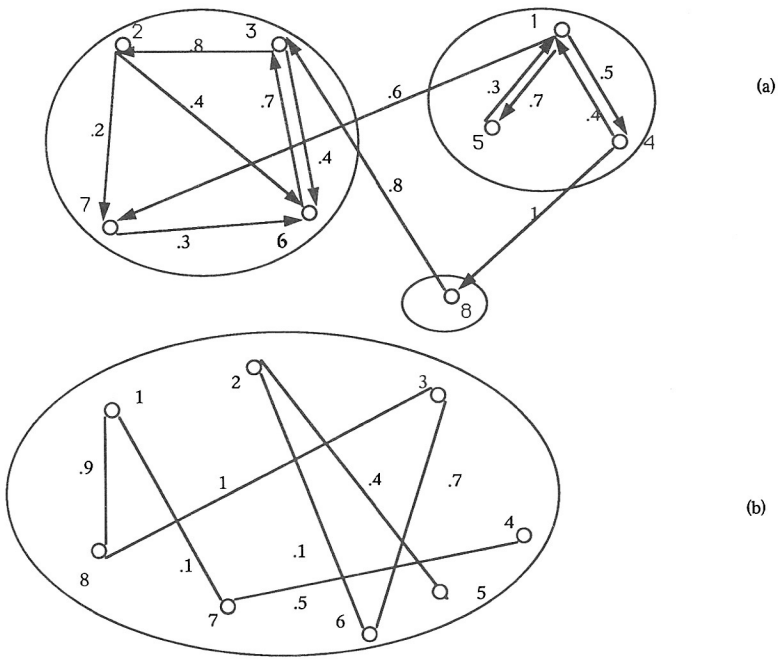

FIG. 2. Cliques in the networks displayed in Figure 1.

time are observed. The frequencies are transformed to strength values between 0 and 1 through a scaling procedure which transforms the observed frequencies so that the strength of connection between the most frequently interacting individuals is 1.

Step 2. Finding the distance between each pair of nodes. A series of connections and nodes is called a path. There can be many paths connecting two nodes directly or indirectly (through some intermediate nodes). The length of a path is obtained by dividing the number of connections on the path by the smallest strength of the connections on the path. The DISTANCE FROM ONE NODE TO ANOTHER is the length of the shortest path from the first node to the second. The DISTANCE BETWEEN TWO NODES exists only if there are distances in both directions between the two nodes, and is defined as the longest of the two distances. If there is no path at all, the distance is infinite. In this step, the distance(s) between each pair of nodes in the network is obtained through a number of matrix operations usually implemented by a computer subroutine.

Step 3. Detecting. By definition, the criterion for a node to be a clique member is that it is connected to every other clique member in both directions. A mathematical procedure is used to detect all node groups that meet the clique criterion in the network at each level. In this study, a soft-

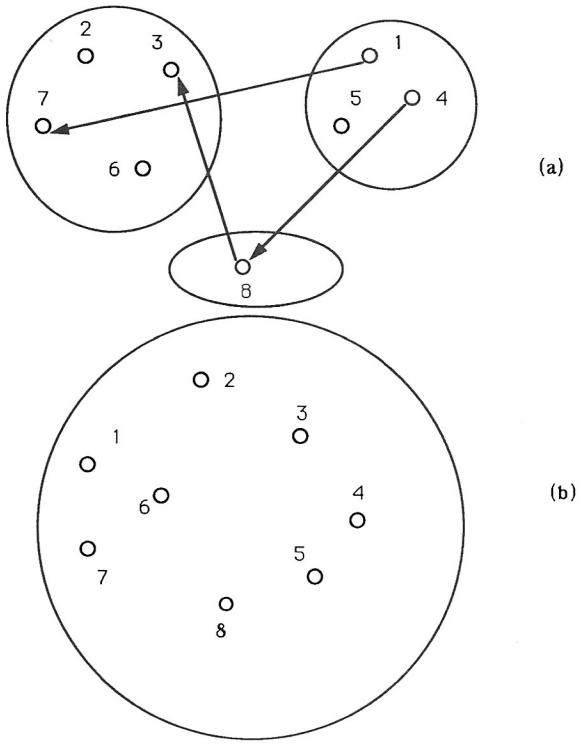

FIG. 3. Alternative display of cliques in Figure 1.

ware CAT, or Clique Analysis Tool (Yan, 1988b), was used for the distance calculation and clique detection. The core algorithm for finding the distance used in CAT is classical and can be found in most discrete mathematics and graph theory textbooks (e.g., Biggs, 1985; Harary, 1969). Readers who want to know basics of the algorithm are referred to Knoke and Kuklinsky (1982, pp. 42–50).

Step 4. Discussion. In this step, one interprets results from Step 3.

The purpose of this paper is to illustrate these procedures by assessing selected aspects of the social and behavioral impact of employment on persons with severe disabilities. In the following sections, we will present the background of the study, the method, and the results.

BACKGROUND

Persons with severe disabilities traditionally have been excluded from the workplace. As recently as 1985, employees with disabilities in 96% of programs funded by state mental retardation and developmental disability

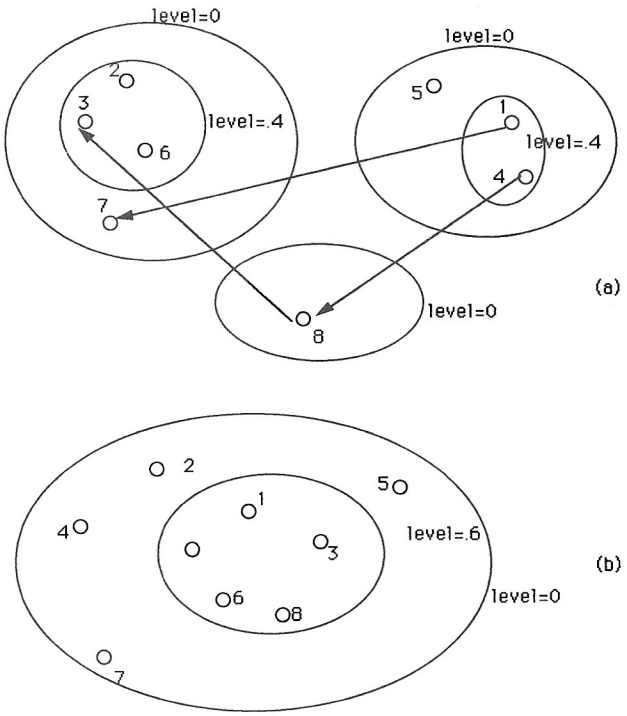

FIG. 4. Cliques at different levels, based on Figure 1.

agencies were segregated from nondisabled workers (Buckley & Bellamy, 1986). Over the past five years a federal initiative has dramatically expanded the opportunities for individuals with severe disabilities to work in integrated settings (Mank, Buckley, & Rhodes, 1990; Wehman, Kregel, & Shafer, 1989; Will, 1984). This initiative is termed supported employment. Supported employment is defined in law (Public Law 98-527 [1984]; Public Law 99-506 [1986]) as employment in typical jobs that includes the presence of continuing publicly funded support. The integration of employees with severe disabilities with employees without disabilities is a key objective of this initiative because it creates the opportunity for developing social relations and reducing isolation (Wehman & Moon, 1987).

Unfortunately, despite the importance of integration, we lack an operational definition by which it can be consistently described in work settings (Mank & Buckley, 1989). This makes it difficult to monitor the effectiveness of behavioral interventions and support strategies designed to decrease isolation at the work place. In an attempt to describe at least some aspects

of integration, many researchers have employed statistical analysis to study interactions among workers with and without disabilities at a variety of work settings based on direct observation (Chadsey–Rusch & Gonzalez, 1988; Chadsey–Rusch, Gonzalez, Tines, & Johnson, 1989; Storey & Knutson, 1989). The basic questions explored in these studies have to do with comparisons of the frequencies and variety of interactions involving employees with and without disabilities.

In this paper, we assert that one of the necessary conditions of integration is that employees with and without disabilities mix or form groups called "cliques" through social or work-related interactions at the work place. Based on this proposition, we can ask the following questions:

1. From a sociological perspective, are there any identifiable groups among employees at the work place?
2. Do employees with disabilities participate in these groups? If so, what is the extent to which they participate? If they do not, then are they to the groups in other ways? How does their way of relating compare to that of employees without disabilities?

To answer these questions, we use Clique Analysis to analyze data from direct observations at one work place (Storey, Rhodes, Sandow, Loewinger & Petherbridge, in press).

In the following sections of this paper, we will describe the subjects, the work place from which data were collected, and the method. A following section will analyze the results. The final section will discuss findings from the analysis and propose possible new support strategies to enhance integration.

METHOD

Subjects and Setting

Data were collected at a plant of a large electronics manufacturing company that employs approximately 400-500 workers (Storey et al., in press). A supported employment program provides training and support to eight employees with developmental disabilities through specially trained supervisors. Seven employees without disabilities worked in the same area. All employees performed similar job tasks, although those without disabilities generally had larger repertoires of tasks. The demographic characteristics of these employees are displayed in Table 1.

Data Collection System

A behavioral observation form was used to record social interactions. Detailed information on this form and the procedures utilized for observations have been reported by Storey and his associates (Storey &

Knutson, 1989). Each of the 15 employees was observed for 12–24 (mean = 19) separate 15-minute sessions. Observations occurred only during work times. An interval recording system of 10-second observe, 5-second record was used and this yielded a total of 60 recorded intervals per session. The observations were conducted by the fourth and fifth authors. Only one employee was observed at a time. The employees were aware of when observations were taking place, but were not told who was being observed during the observation session. If an interaction occurred during the 10-second observe interval, the data collectors recorded with whom the interaction occurred (e.g., a nondisabled coworker), the name of the interactor (e.g., "Jenny"), and the type of interaction (e.g., worker conversation) using a paper and pencil data collection system. Observers recorded 10 categories: assistance, instruction, teasing/ provocation, criticism, social amenities, compliments, work con-

TABLE 1
Description of Employees With and Without Disabilities

Name	Node	Age	IQ	ABS %[a] Score TMR[b] Norms	ABS Verbal Ability[c]	Communication Ability
Larry	D1	25	43–50	89	11	Uses gestures and one-word utterances
Stewart	D2	21	<10	12	0	Nonverbal and deaf; limited sign language ability
Sam	D3	20	36	96	15	Able to speak in sentences
Karen	D4	21	30	34	2	Limited verbal ability; uses some signs
Jay	D5	21	34	67	3	Uses gestures and one-word utterances
Teresa	D6	23	34	100	13	Able to speak in sentences
Julia	D7	25	36	58	7	Speaks Spanish; limited English
Peter	D8	22	33	85	9	Able to speak in short sentences
Rick	N1	26	Not available			Speaks in both Spanish and English
Jenny	N2	22	Not available			
Vance	N3	28	Not available			
Eva	N4	19	Not available			
Josh	N7	22	Not available			

[a]ABS = Adaptive Behavior Scale.
[b]TMR = Trainable Mentally Retarded.
[c]Questions 25, 36, 39, and 40 from Adaptive Behavior Scale (Range 0-16).

versation, personal conversation, other, and unknown. The initiator and the receiver of the interaction were recorded for all interactions except for work conversation, personal conversation, other, and unknown. Interaction categories were mutually exclusive, though more than one type of interaction could occur during an interval.

Interobserver agreement was calculated on 51 (14%) of the 353 observation sessions. Interobserver agreement on the occurrence of an interaction was 95.5%. Interval-by-interval agreement was 93.5%. Interobserver agreement on the nonoccurrence of an interaction was 99.1%. The overall kappa for whether an interaction occurred was .88.

Because the amount of data collected on criticism, teasing/ provocation, and other were very low, we excluded these categories from analysis. Five categories of interaction were analyzed. The first category of interactions was obtained by collapsing data on assistance and instruction. This category includes asking, receiving or providing assistance, directions, prompts, and corrections regarding a task (kappa = 0.89). The second category is compliment, including getting from or saying to another person a reinforcing statement (kappa = 0.80). The third category, social amenities, includes exchanging greetings (kappa = 0.75). These three categories are all directional interactions. The fourth and the fifth categories are personal (kappa = 0.75) and work conversation (kappa = 0.85), including verbal interchanges beyond social amenities that are nonwork- or work-related. These two categories do not have direction. For each of the five categories, the number of interactions between each pair of persons was added together (in the cases of Categories 1–3, the number of interactions were added by direction), a network was established and cliques at different levels were detected.

RESULTS

The highest average number of interactions in any category during a 15-minute observation session was 10. This means that in these five networks, the number of sessions multiplied by 10 is the highest possible number of interactions of a given category. Based on this observation, we defined the strengths of connections in these networks as:

$$\text{strength} = \#\text{ of interactions}/(10 \times \#\text{ of observation sessions}).$$

Since this study is a one-time, one-place study, only one network was defined for each category.

In these networks, persons with disabilities are denoted by Di, i = 1, 2,...,8. The supervisor is denoted by S. Persons without disabilities are denoted by Ni, i = 1, 2,...,7. Figure 5 shows the results of clique analysis for the interaction assistance and instruction network.

In Figure 5, cliques detected at levels 0–1.0 at an increase of 0.1 are displayed. In this figure, we observe that at level .1, one clique was detected that has members S and D8. When the level was reduced to 0, six more nodes representing six employees with disabilities joined the clique. All members in cliques are with disabilities except the supervisor. This shows that the social interaction pattern of employees with disabilities was structurally distinguishable from that of nondisabled employees if one only looks at instruction and assistance. Nondisabled employees are not clique members at any detection levels. Note that according to the definition of a clique, S also received some instruction or assistance from employees with disabilities.

N1, N2, and N3 provided instruction and assistance to others but received none. N4 and the clique both received and provided instruction and assistance. N5, N7, and D2 received but did not provide instruction or assistance. N6 was not involved in any interaction. S and D8 played central roles in the cliques, showing that they were most involved in assistance and instruction.

The analysis suggests that there was enough instruction and assistance going on among the employees with disabilities to form an interaction clique, and the nondisabled co-workers' involvement was not significant enough to be considered a part of the clique activities. In terms of the rela-

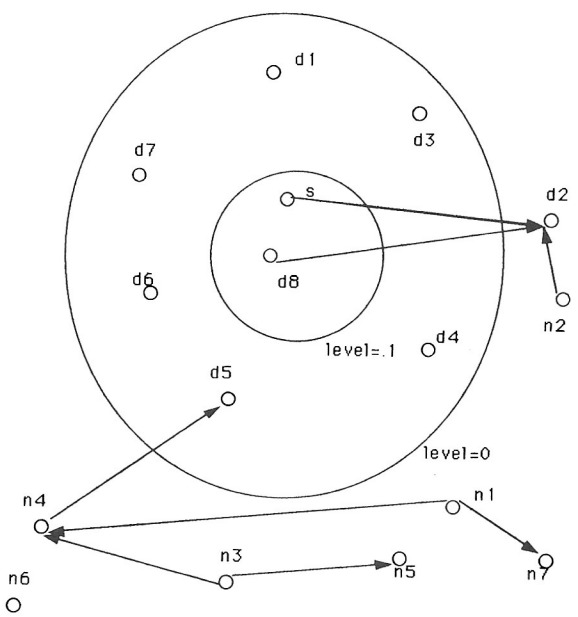

FIG. 5. Cliques in Assistance and Instruction Network.

tive position in this category of interaction, there is a clear structural difference between the two employee groups. The levels at which the cliques were found are low, suggesting that instruction and assistance did not serve as a major means for social interaction, and the employees with disabilities were working rather independently.

Figure 6 displays the results of clique analysis for the compliments network; the highest level at which a clique was detected is .1. The clique involves S and D6. At level 0, three disabled employees and four nondisabled employees joined the clique. All outsiders of the clique were observed receiving compliments from members of the clique except N5. Structurally, these outside nodes that received compliments are all interaction receivers, and the clique as a whole served as the interaction initiator. About 50% of clique members were employees with disabilities, and 50% without. In this network, the grouping pattern of employees with disabilities in the employment program is no longer distinguishable from that of employees without disabilities. The two employee groups are mixed together. No structural difference between the two groups can be found. It is also clear from Figure 6 that the central figures in the clique were D6, S, and N6. They were the most active persons in providing and receiving compliments. The supervisor again played a central part.

On the whole, these results suggest that there were enough exchanges of compliments to allow a clique to be found, and employees with and without disabilities played approximately the same structural role in this social function. As reflected by the low detection levels at which cliques were found, the number of compliments exchanged was relatively small, suggesting that like instruction and assistance, compliments were not a major part of the social interaction that happened at the workplace.

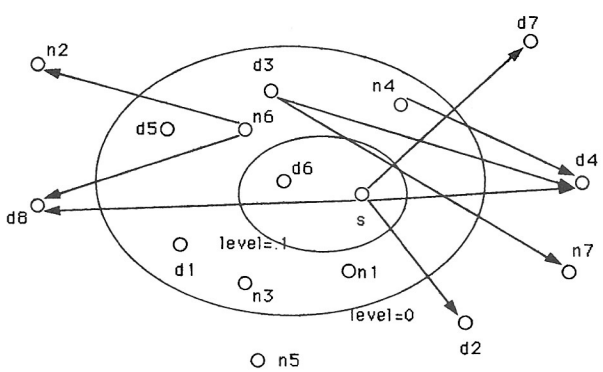

FIG. 6. Cliques in Compliments Network.

Figure 7 displays the results for the social amenities network. Compared with the previous two networks, the amenity network displays a more complex structure. At level .3, one clique, C1, was detected that had two members, S and D7. At level .2, D2 and N3 formed a clique, and D8 joined C1. At .1, D1 joined C1, and C2 expanded to become a seven-member clique, four employees having no disabilities and three having disabilities. At level 0, when all connections with nonzero strengths were taken into account, C1 and C2 merged into one large clique. Everybody except D2 was a member of this large clique. The reason D2 was not a member is that he received but did not provide social amenities to other workers. In Figure 7, we see that S, D7, D1, N3, and N1 are central nodes of the cliques at different levels.

On the whole, noting that C1 was first detected at the level .3, we find that social amenities occurred at a relatively higher level as compared to the previous two categories, showing that exchanging social amenities was a more frequent mode of social interaction. The existence of C1 shows that the supervisor and a few employees with disabilities tended to form a clique together. There was a detectable structural difference between social positions of these individuals and other employees. On the other hand, about half of the employees with disabilities formed clique C2 with employees without disabilities at detection levels 0.1 and 0.2, showing an encouraging sign of integration. At level 0, the two cliques merge together and all but one employee is included in the clique. The clique pattern shows that integration through social amenities was occurring among some employees with disabilities at relatively high detection levels and to almost all workers at lower levels.

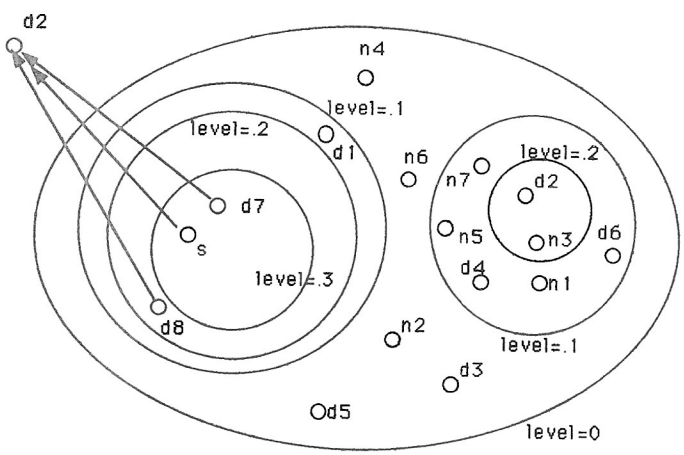

FIG. 7. Cliques in Amenities Network.

Figure 8 shows the results from work conversation; all employees without disabilities formed a clique at the highest detection level (1.0). No employee with disabilities was involved. At level .8, the supervisor and an employee with disabilities formed a small clique. At .7, members of these two cliques and one more employee, D6, merged to form a bigger new clique. As we lowered the level of detection, all employees with disabilities eventually joined the clique.

A detectable structural difference between the clique patterns of employees with and without disabilities at detection levels 0.8–1.0 is suggested by this result. About 50% of the employees with disabilities did not join the clique until the detection level was lowered to 0.2. However, this picture also shows that at detection levels 0–0.7, certain levels of communication regarding work were going on among all employees and the employees with disabilities were in different states of involvement. Comparing the levels of interaction in this network with the previous three interactions, we find that "talking about work" was one of the major interactions that occurred at the work place.

Clique analysis of personal conversation (see Figure 9) shows that six of the seven employees without disabilities engaged in personal conversation at the highest level (1), and two of the employees with disabilities formed a clique with the supervisor at level 1. When the level was lowered to .8, these two cliques merged and D5 was included. At level .6, the last non-disabled employee, N3, joined the clique. All other employees with disabilities except D8 joined the clique as the detection level lowered from 0.6 to 0.

Detectable differences in interaction patterns between two groups of employees are suggested by this graph. First, at high levels, employees

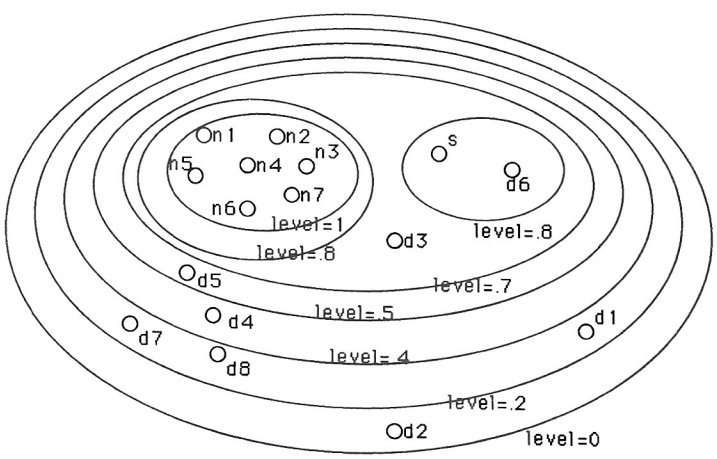

FIG. 8. Cliques in Work Conversation Network.

with disabilities and employees without disabilities belonged to different cliques. Second, all employees without disabilities were involved in the clique at level .6, while at the same level, most of the workers with disabilities were still outside of the cliques. As in the work conversation network, the levels of personal information exchange were considerably higher than those of the first three categories. At level 0, almost all employees with disabilities became clique members, indicating that different levels of communication existed among workers with and without disabilities regarding nonwork related information.

DISCUSSION

Several limitations in the results should be noted. First, it was assumed that when a conversation happened, each of the participants spent approximately the same amount of time talking. While this may be true with some employees, it may not apply to all employees. This is a source of distortion in the analysis of the work conversation and the personal conversation networks. Second, this study was based on data collected from one particular work place during work time. The result cannot be readily generalized to other supported employment settings or to times such as lunch or break. Third, direct observation techniques create limitations resulting from reactivity, although attempts to control reactivity were made through the use of nonintrusive data collection methods (Haynes & Horn, 1982), and through frequent presence of data collectors within the work environment.

At the beginning of this paper, we proposed that persons with disabilities integrated at work settings may form cliques with co-workers without

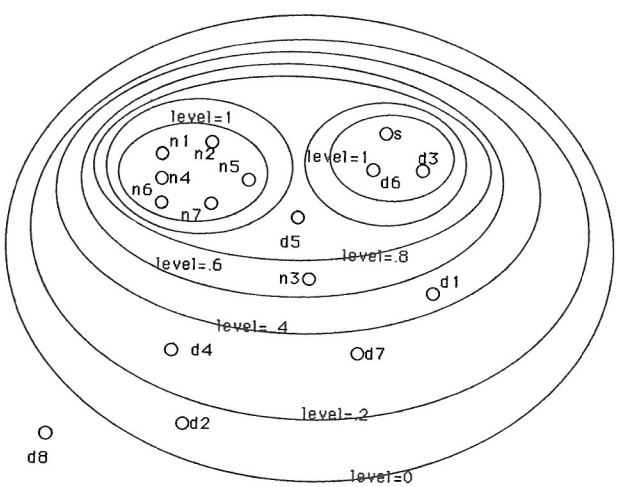

FIG. 9. Cliques in Personal Conversation Network.

disabilities. The opposite proposition is that workers with disabilities will be totally segregated and that employees with and without disabilities will not interact. Two sample graphic representations of clique analysis results depicting full segregation (Figure 10a) and full integration (Figure 10b) are given in Figure 10.

The results from clique analyses of the five interaction networks and comparisons of Figure 5 through Figure 9 with Figure 10 support several conclusions. First, most interactions among employees occurred in the form of personal and work conversations. In both networks, when the detection level was set about 0.7 or higher, detectable differences in clique patterns between the two groups of employees were found. Most employees without disabilities formed cliques with each other, while a few employees with disabilities and the supervisor formed different cliques. However, at relatively low detection levels, almost all employees with disabilities joined the clique, and small social circles found at higher levels always merged into bigger ones. At these lower levels, employees from two groups mixed together and no structural differences were detected.

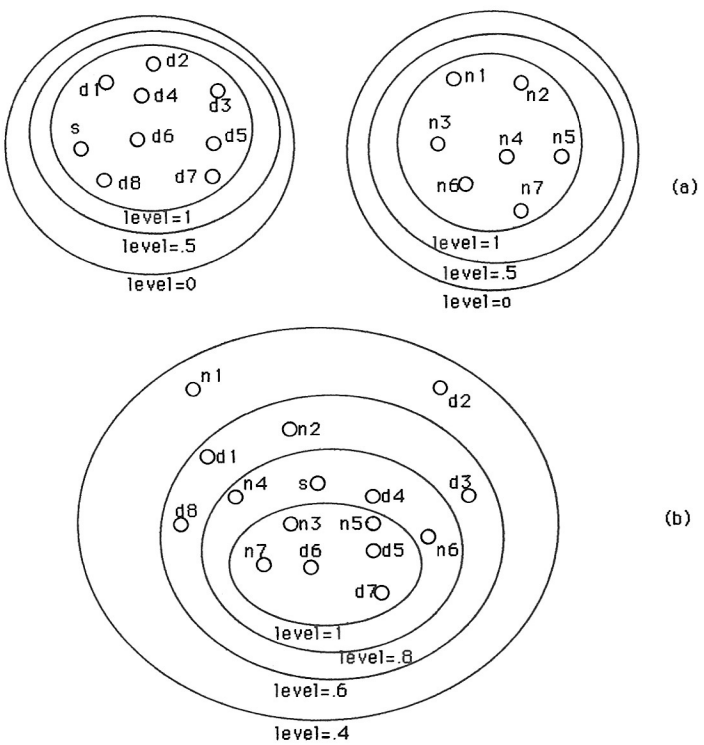

FIG. 10. Two extreme cases of social integrations. The top figure represents total segregation; the bottom, total integration.

Information from the analysis of these two interactions suggests that employees with disabilities were neither fully integrated nor fully segregated; they were in different states of integration between the two extreme cases. In order for integration to improve, efforts should be made to get employees with disabilities more involved in work and personal conversations with nondisabled co-workers. One possible way to make this happen is to change the supervision strategy so that the nondisabled employees become more involved in the training of the employees with disabilities. Another is to disperse employees with disabilities so that each works alongside a greater number of nondisabled co-workers. A third is to increase the communication ability of the employees through behavioral training, or the use of augmentative communication systems. Of course, what level of integration is "satisfactory" remains to be established.

Second, enough interactions involving social amenities and compliments were found to form detectable cliques at low levels. Unlike the cases of work and personal conversations, the networks involving these two categories showed little detectable structural difference between the two groups of employees, demonstrating similar levels of these kinds social interactions.

The clique in the instruction and assistance network reflects an important feature of supported employment programs—the ongoing support to persons with disabilities after they are employed. In addition to providing skill training and supervision to employees with disabilities, ongoing support also provides a certain amount of social interaction. However, an important question to ask is from whom do employees with disabilities receive ongoing support? The clique analysis for this work setting shows that most ongoing support came either from the supervisor or from other workers with disabilities, leading to the formation of a clique among the employees with disabilities. Again, to achieve integration, it may be preferable for workers to derive most ongoing support from co-workers without disabilities and form cliques with them. The assumption is that if workers with disabilities are more involved in training and assistance with their co-workers without disabilities, opportunities for work and personal conversations among co-workers without disabilities will improve. This support strategy may be more difficult to implement, but can better promote integration.

While the clique analysis reveals differing states of integration, it also sends some warning signals to us. Looking across all graphs, one finds that D2 and D8 were either outsiders in the network or interacted with others at the lowest level. This indicates that they were not integrated as well as other employees with disabilities. It is possible that the levels of integration may be largely a function of the disabled employees' limited verbal repertoires. Though social interactions do not have to be verbal (e.g., shak-

ing hands), they usually are. While D2 has some major limitations in communication because he is nonverbal and deaf, D8 has a high adaptive behavior verbal ability score and can speak in short sentences. This suggests that the reasons for the relative isolation should be explored and ways found to improve D8's communication patterns.

In all the networks, at relatively higher detection levels, the supervisor formed cliques with two or three employees with disabilities. Most of the employees with disabilities were not included in the clique. On the one hand, this shows that a supervisor is important in providing interactions; on the other hand, it also shows that the current support available to employees with disabilities cannot provide social interactions at a level the nondisabled peers enjoy, and some changes in support strategy should be considered. On the whole, if our proposition in this paper is true, then there must be changes in interaction patterns before full integration occurs.

In concluding this paper, we should make some comments regarding clique analysis and its applications. First, although the study described in this paper was designed as a one-time study and all the networks were analyzed only once, clique analysis can be used by service providers and program providers across time. The results will show changing grouping patterns which reflect progress in social integration. Based on this information, service providers can design alternative support strategies to promote integration. Second, clique analysis can be used to compare integration across different industries or supported employment approaches (e.g., individual job placement versus groups of persons with disabilities working in close proximity to each other). By examining clique patterns in these approaches, we can see which industry or program better facilitates social interactions. A strength of clique analysis is that its structures not only include the interactors but also the magnitude of interactions between them. This allows one to observe social behaviors of individuals quantitatively and in relation to each other. Finally, clique analysis offers an additional analysis system to be utilized in behavioral assessment. Clique analysis may prove useful in many different settings for behavioral researchers, including classrooms, small groups, and workplaces.

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