Six Degrees of Separation: An Exploratory Network Analysis of Mentoring Relationships in Pediatric Psychology

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Objective The present study is an exploratory social network analysis of mentee–mentor relationships in the field of pediatric psychology. Method An online survey was distributed to members of the Division 54 Society of Pediatric Psychology (SPP) listserve asking them to name up to 10 psychologists from whom they had “received mentoring” and who influenced their careers. Directed network analyses were conducted to examine features of the resulting mentoring network. Results Participants reported receiving mentoring in a wide variety of relationships and settings. The average “degrees of separation” between individuals in the network was 5.30. Conclusion: The field of pediatric psychology is interconnected with professionals learning from multiple mentors in multiple settings, extending beyond just graduate student advisors. Overall, many different mentors were listed, and there does not appear to be only one or two individuals providing the majority of mentoring within the field.

Key words mentoring; networks; pediatric psychology; training.

Introduction

Mentoring has been described as “a form of professional socialization whereby a more experienced individual acts as a guide, role model, teacher, and patron of a less experienced protégé…to further develop and refine the protégé’s skills, abilities, and understanding” (Moore & Amey, 1988, p. 45). Additionally, Chao (2009) offered that “mentors are experienced professionals who are personally involved in the career development of a junior professional or mentee” (p. 314). Mentoring relationships are highly valuable for professional development in many fields including psychology; for example, more than 90% of recent clinical psychology doctoral graduates reported having a positive mentor relationship and, in turn, greater satisfaction with their graduate training (Clark, Harden, & Johnson, 2000). Overall, mentors can subsume a large number of roles, including teacher, trainer, confidant, leader, and advisor (Walfish & Hess, 2001). Through these roles, mentors assist mentees by stimulating ideas, giving information, believing in the mentee, enlarging the mentee’s perspective, and providing the mentee with opportunities to learn. The characteristics of both the mentor and mentee can impact the outcomes of the relationship (Walfish & Hess, 2001); therefore, each mentoring relationship may be unique in its successes and opportunities. This suggests that mentees may benefit from being engaged in numerous mentoring relationships or networks because each relationship presents the opportunity for unique growth.

A network is a structure of individuals who interact, collaborate, or influence one another, and networks have been examined in both social and knowledge-based systems (e.g., anthropology, business administration, sociology, economics; Liben-Nowell, 2005). These networks help to form a basis for shared norms, identity, and collective behavior and are present in entities such as...
membership organizations (de Nooy, Mrvar, & Batagelj, 2005). Graphically, networks are often depicted as a series of nodes/vertices (dots or circles to represent individuals or actors in the network) and interconnecting lines (to represent the links between individuals). These lines can be directed (i.e., termed an arc; mentee names a mentor; therefore, the line between these individuals is represented by an arrow with the tail of the arrow starting with the mentee and the head of the arrow directed to the mentor) or undirected (i.e., edge; line has no arrow as relationship between individuals is equal; e.g., two children within a family are linked as siblings). Past research on specific mentoring networks has typically depicted associations as directed hierarchical genealogies or pedigrees in which top-down connections are developed between a mentor and the mentee (e.g., single linear relationship between mentee with dissertation chair). However, such depictions do not capture the complex, multifaceted nature of the mentoring process and the potential vast influence a mentor may have on a number of trainees and other professionals (Wilson & Johnson, 2001).

Mentoring relationships create linkages between individuals and can aid in the development of larger networks, which allow for collaboration within and between professions and academic fields. However, when either an individual person or a small cluster of individuals becomes isolated from the rest of the network, many areas of research and clinical progress, as well as overall individual professional development, may suffer (e.g., Eaton, Ward, Kumar, & Reingen, 1999). Therefore, networks that integrate individuals across a discipline and that connect individuals to numerous other professionals promote the greatest potential for the field to develop maximally and for individual professional development.

Integrated networks can be said to exhibit the “small world” phenomenon, wherein any two individuals can be connected through a short sequence of linkages between other individuals (Kleinberg, 2000), regardless of the overall size of the network. This concept stems from the work of Stanley Milgram (Milgram, 1967; Travers & Milgram, 1969), who examined the probability that two randomly selected people would know one another by having participants forward a mailed letter intended for a target person. Of those letters that reached the target, the average number of exchanges was six; hence, the experiment was interpreted as showing that all people are connected to one another by an average of six degrees of separation. This “small-world” concept has also been demonstrated among social contacts on a college campus and in a replication of Milgram’s original study via an email-based social search study to examine chains in forwarded email messages attempting to reach 18 target persons across 13 countries (Dodds, Muhamad, & Watts, 2003; Portnova, Frazer-Lock, Ladd, & Zimmerman, 2007).

**Mentoring and Networks in Pediatric Psychology**

The Society of Pediatric Psychology (SPP) serves the formal organization and group identity of the field and has been instrumental in the emergence of pediatric psychology as a distinct area in psychology (Aylward, Bender, Graves, & Roberts, 2009; Roberts, 1993). The field of pediatric psychology is a multifaceted and ostensibly integrated field of professionals working on a range of problems affecting children and their families (Aylward et al., 2009). Professionals in the field have long recognized the importance of mentoring in the training and professional development of pediatric psychologists (Rosenthal & Black, 2006; Routh, 1980; Spirito, Brown, D’Angelo, Delamater, Rodrigue, & Siegel, 2003). This importance is evidenced by several activities sponsored by SPP, including the annually awarded Martin P. Levin Mentorship Award, the Mentoring Connections program that matches students and early career professionals with more senior mentors, as well as a program for supervised reviews of manuscripts submitted to the Journal of Pediatric Psychology (Wu, Nassau, & Drotar, 2011).

According to a recent Mentoring Task Force survey within SPP, almost all respondents rated mentoring as important to very important in their professional development. Additionally, almost half of the respondents noted having several mentors, each of whom contributed to different areas of professional development (i.e., research, clinical work, leadership/administration; http://www.societyofpediatricpsychology.org/mentorship/).

In fact, the continued growth of the field of pediatric psychology is often attributed to mentorship in training and collegial relationships. Historically, professionals in pediatric psychology established strong affiliative relationships that were beneficial to individuals’ success and helped develop a vibrant and networked field long before the more recent organized efforts (Drotar, 2001). Although many mentor–mentee relations resulted from a natural development of more senior professionals assisting a new generation, the focus on mentoring more recently has been oriented to facilitating the process. Regardless of whether the relationship is created formally or informally, the length of the relationship, or the level of mentoring, these relationships create networks and connections between individuals, facilitate transfer of knowledge and skills, and support development of a professional identity. This is particularly relevant given the vast set of research, clinical, and teaching skills and activities conducted within the field of pediatric psychology (Drotar, 2003).
Ultimately, these networks of mentors and their mentees form the integrative character of pediatric psychology and allow the field to thrive.

**Rationale of the Current Study**

Despite the identified importance of mentoring in pediatric psychology, to the authors’ knowledge, there are no published analyses of the network of mentoring relationships in the field. Therefore, the present study explored the nature of these mentoring relationships and the interconnectedness of relationships within the field’s formal organization, SPP. An empirical investigation of the topology of mentoring in SPP can provide information on the organizational structure of the field by understanding the interconnectedness of professionals through mentoring. As previously discussed, research outlining the structure of networks established through mentoring in other fields has typically utilized “top-down” single nodal depictions of genealogy, despite the fact that this approach does not allow for the capturing of the complexity of mentoring relationships (e.g., the possibility that a mentee or mentor may engage in multiple mentoring relationships). The current study overcomes this limitation by illustrating mentoring relationships in the field of pediatric psychology through a “web-like” network that could capture various intertwining interaction amongst professionals, highlight specific clustering systems, and allow analyses of the individual connections and links between individuals. Additionally, the present study sought to provide a description of the types of mentoring relationships occurring within the field, such as the number of mentors participating professionals identified and the settings in which these relationships occurred. This description of mentoring relationships and interconnectedness within the field provides a crucial first step in providing a base for future research examining how this network influences practice, knowledge exchange, and development within our field.

**Methods**

**Participants**

The mentoring network for this study was created by distributing an online survey to members of the SPP listserv. The survey asked consenting participants to name up to 10 psychologists from whom they “received mentoring” and who influenced them in their career through either a direct or formal relationship. The decision to allow listing of up to 10 mentors was made because pediatric psychologists frequently receive mentoring through prolonged professional development throughout their careers, and therefore frequently have a large number of mentors. However, participants were not required to provide names of 10 mentors, and therefore individuals with fewer mentors were not required to list more names than they felt necessary. Additionally, attempts were made to contact named mentors via email to request their participation if they had not yet completed the survey. Respondents were also asked to categorize the mentoring relationships based on the type of professional relationship (i.e., advisor, clinical or research collaborator, collaborator in other professional activity, other) and the setting in which the relationship took place. Respondents were allowed to indicate more than one category for each mentoring relationship.

**Linking Mentors and Mentees**

Respondents used the Qualtrics Survey Research Suite to manually enter their mentors. To ensure that all mentee-mentor linkages were correctly identified, a directory of identified mentors was created using Microsoft Excel to account for variations in named mentors. Reasons for variations in named mentors included inclusion/exclusion of maiden names, hyphens in names, inclusion/exclusion of middle initials, and/or spelling of first names (e.g., Dennis Drotar vs. Denny Drotar). All mentee–mentor links were then manually entered into a database using the name as it appeared in the final directory.

**Mentoring Network Metrics**

NodeXL version 1.0.1.161 (http://nodexl.codeplex.com) was used to analyze the overall relationships within the mentee–mentor network and conduct a descriptive analysis of connections between professionals in the network. A directed network analysis was used to evaluate the overall network, meaning that the connections between individuals reflected the directed link between mentee and the mentors he/she named (i.e., Mentee → Mentor; as depicted in Figure 1, person B identified person A as a mentor, but not necessarily vice versa). Although many statistics can be derived from social network analyses, the ones presented for this exploratory network analysis generally focus on the network as a whole rather than one’s individual standing or prestige in the network. For individually based statistics, summary values are used to describe the average individual statistic based on those in the current sample.

Although recognizing that mentoring relations are constantly evolving, descriptive statistics were computed to summarize key facts about the distribution of mentor–mentee relationships based on those completing the survey for this study. Specifically, statistics were computed to assess interconnectedness or cohesiveness among individuals in the network. This included the graph density.
statistic (a ratio of the number of total arcs or links between individuals in the network by the maximum number of possible links (percentage), with higher values indicating a more complete or dense network). Graph density values can range from zero to one, whereby if all pairs of individuals are linked to one another then the network is said to display maximum density (i.e., value 1.0) or be a complete network. It should be noted, however, that there is an inverse relationship between density and network size; that is, the number of potential links increases significantly with more individuals in the network, and thus one would expect to find lower overall density statistic with larger networks. As a result, the number of arcs directed toward an individual (in-degree) and number of arcs from an individual to another individual (out-degree) may provide additional information on the cohesiveness of the network. For example, in Figure 1, the in-degree for individual B in the hypothetical network is two, whereas the out-degree for him/her is four. Thus, his/her overall degree centrality would be six (in-degree + out-degree).

Another important concept to assess in networks is the ability to form connections or transmit information. This includes the social distance between individuals in the network (i.e., shortest number of steps or links it takes to reach another individual in the network; average geodesic distance statistic). Second, closeness centrality examines the social separation between an individual in the network and all other mentees or mentors in the network. For a given individual, the closeness centrality is the number of other individuals in the network divided by the sum of all distances between that individual and others. Closeness centrality ranges from 0 to 1; if one is connected to all other nodes in the network, his/her closeness centrality value would be 1.0. If an individual is close to all other individuals in the network, he or she is able to make connections or share information more easily; finally, the betweenness centrality statistic examines one’s position in a network and ability to make connections to other individuals or groups in the network (i.e., proportion of all geodesics between other individuals in the network that include that individual). For example, in Figure 1, individual G would have a high betweenness centrality as he/she connects Individuals B and H and would represent a single point of failure of connectedness between B and H if not in the network; thus, individual G serves as an important intermediary in the network. If someone was to be removed from the network, and it did not alter any other connections or shortest connection paths, their betweenness centrality value would be 0; thus, a higher betweenness value suggests a stronger influence on the overall network. Overall mean values of these statistics were used to describe the average relationships experienced by professionals in the network based on survey responses.

Results
Respondents to Survey
A total of 286 participants (63.6% female) completed the Qualtrics web survey. The majority of respondents received training in clinical psychology (n = 227, 79.4%), followed by those reporting as other (e.g., cognitive neuroscience, social psychology, combined programs; n = 28, 9.8%), counseling psychology (n = 12; 4.2%), developmental psychology (n = 10; 3.5%), and school psychology (n = 7, 2.4%). Two individuals who completed the survey did
not specify their training background (0.7%). On average, respondents were 16.80 years post-graduation (SD = 12.80; Note: 16 respondents had not yet received their doctorate degree and thus were not included in this average). Survey participants identified a total of 1,783 mentors (1,007 unique named mentors; 54.1% male). On average, each survey participant identified about six mentors (M = 6.23; SD = 2.76).

Descriptive Statistics of Mentor–Mentee Relationship

Mentoring Location
About half of all mentoring interactions were coded to have occurred in medical settings (i.e., medical center/hospital, medical clinic; n = 893; 50.4%), followed by colleges and universities/research institutes (n = 748; 42.2%), and 2.2% through professional societies/organizations (n = 39). Nearly 4% of identified mentoring relationships (n = 62; 3.5%) took place across more than one setting (e.g., academic institution and hospital). The location of where the mentoring occurred was not defined for 10 of the named mentors, and 0.5% (n = 9) of the locations were not able to be coded because the site description provided by the respondent was nonspecific (e.g., “long-distance,” listed as “fellowship” without stating where fellowship training took place).

Type of Mentoring Relationship
Respondents categorized the majority of the mentors as an advisor, professor, instructor, clinical or research supervisor, and/or dissertation chair (n = 1,301; 73.4%), followed by professional collaborator in research (n = 429; 24.2%), professional collaborator in clinical work (n = 269; 15.2%), professional collaborator in other professional activity (n = 223; 12.6%), and other (n = 88; 5.0%). The type of mentor was not defined for 10 of the named mentors. Although the majority of mentoring relationships were defined only by a single category (n = 1,394; 78.6%), 14.2% of the relationships were categorized by two of the above categories (n = 251), and 7.3% by three or more of the mentoring relationship categories (n = 128).

Mentoring Network Metrics
A listing of the mentoring network metrics is provided in Table I. The overall graph density was 0.0014, indicating the model did not have a dense pattern of connections. Stated differently, only 0.14% of all possible arcs or directed lines were present in the current network; however, this is strongly influenced by the size of the network (1,007 unique individuals) and the limits imposed in the survey (i.e., able to identify only up to 10 mentors).

Participants identified up to 10 mentors (M = 6.23; e.g., in Figure 1, Person B identified Persons A, C, D, and E as mentors; out-degree) and the number of times each individual in the network was identified as a mentor ranged from 0 to 29 (M = 1.60; in Figure 1, Person B was identified as a mentor by Persons G and F; in-degree). Similar to the notion of six degrees of connectivity, the average geodesic distance between individuals in the mentor–mentee network was 5.31 (maximum geodesic distance = 11), meaning a mentor or mentee was connected to any other individuals within the network by around five linkages or connections. The average betweenness centrality value for all individuals in the network was 4665.78, and closeness centrality statistic was 0.001, which again can be influenced by the limitations imposed on the survey. A listing of the network metrics for the top 100 individuals based on an overall network connectivity statistic is provided in supplementary materials. (Note: N = 101 because of tied ranks. Overall network connectivity rank is omitted from the table, and individuals are listed in alphabetical order). A graphical illustration of the mentee–mentor network using the Fruchterman-Reingold force-directed layout based on the survey respondents is available in supplementary materials as well.

Discussion
The purpose of the present investigation was to provide an initial examination of network of mentor and mentee relationships in the field of pediatric psychology and to identify the level of interconnectedness within the discipline based on survey respondents. Our results identify a diverse and complex mentoring network between individuals in the field of pediatric psychology. The current results also highlight the dispersion of connections within the field participating in this survey. That is, based on the overall graph density and average closeness centrality statistics, many clusters of connections were identified rather than
a few influential nodes that one might expect to find in a field dominated by a few highly influential “powerhouses.” Finally, the network identified in this study suggests that most students and professionals in the field experienced mentoring relationships with a variety of individuals and in multiple settings throughout their careers.

Clusters Not Nodes
The large number of named mentors with high network connectivity statistics seems to illustrate that no single person (or persons) controls access to the field. Rather, the field of pediatric psychology is best characterized by interconnectedness and interdependency, and this diffusion of access and influence represents a strength within the field. The scientific process requires a multiplicity of perspectives for a field to survive. The finding that the central forces within the pediatric psychology network is a large group of connected individuals, rather than only a handful of key mentors passing on their ideas to the next generation, reflects the field’s history of multifaceted work with many influences.

In addition, the results of this study suggest the importance of mentoring relationships in establishing this professional network within the field. The multitude of connections seen here represents only mentoring relationships. Certainly, professionals interact and develop networks through many other mechanisms as well; however, these results highlight the centrality of mentoring in creating a firm base for the field to grow and connect. This high level of interconnectedness fostered through mentoring may be why other research has found that mentors cite development of a professional network as one benefit they have received through providing mentoring (Canter, Kessler, Odar, Aylward, & Roberts, 2012).

Multiple Mentors and Settings
One aspect contributing to the high degree of interconnectedness was that mentees identified numerous mentors, and many participants submitted the maximum number of 10 mentors. In this way, even this number of participants resulted in a large network with numerous pathways between individuals. Furthermore, the naming of multiple mentors evidences important factors about the perceptions of mentoring within the field. For instance, named mentors represent more than traditional graduate advisors and internship directors. This finding suggests that participants considered a variety of professionals as important to their success and development. Furthermore, many mentors served multiple roles or across multiple settings (e.g., academic institution and hospital), indicating the perception of mentoring as an on-going and multifaceted part of professionals’ development. The naming of such a large number of mentors by each participant shows that mentoring may be a more integral piece of pediatric psychology practice and training in comparison with other subfields within psychology, where as few as 65% of professionals from a national membership association with varying training backgrounds (e.g., school psychology, clinical psychology, educational psychology, counseling psychology) and those involved in graduate level school psychology could identify at least one mentor during their career (Swordlik & Bardon, 1988).

Suggestions and Conclusions
Given that pediatric psychology is by its nature a multifaceted and integrative field, it is likely that no one mentor is capable of imparting all the knowledge and experience a mentee needs in their research and clinical practice. Certainly, a more traditional one-to-one view of mentoring—studying only at the “feet of the master”—is not a viable means to approach the field of pediatric psychology. As a result, students and early career professionals should expect (and, indeed, seek out) multiple mentors across a wide variety of settings. Although many graduate training programs encourage students to identify a single primary advisor, students in the application process may be well advised to consider the opportunities for forming meaningful mentor–mentee relationships beyond their primary advisor as they make decisions. Similarly, mentors may be able to provide an important service by helping students to gain new skills in navigating multiple mentoring relationships. In a field characterized by multiple mentors, students should be encouraged to synthesize multiple (and, inevitably, sometimes competing) perspectives to develop their own framework.

Finally, the current results hold implications for methods of dissemination within the field. Because there does not appear to be any single individual (or even a few individuals) that define the network, there is similarly not likely to be a small group of “gatekeepers” that control information flow in the field. Given the fact that many participants identified several mentors spanning location and time, envisioning any one institution or group as the sole experts on a particular subtopic in the field may be difficult. As professionals move about and form new meaningful relationships, clinical expertise, concepts and approaches, and research programs move with them and grow to accommodate new ideas. Future researchers may wish to “track” a particular topic within the field (e.g., chronic abdominal pain) to explore how clinical applications and research
questions travel through the network of pediatric psychologists. For example, an understanding of this process may have implications in terms of increasing the accessibility and sharing of research findings and clinical expertise.

**Future Research Directions**

These findings need to be considered within the context of the current study. The present study represents a single snapshot of the current status of mentoring relationships in the field of pediatric psychology. A number of alternative methods (e.g., analyzing such metrics as co-authorships, all professional relationships, or specifically defined mentoring relationships) could potentially identify different networks within pediatric psychology. However, the current open-ended, mentor-only methodology was used in an attempt to include relationships with psychologists across multiple settings and professional contexts (e.g., research, clinical, teaching) and to allow participants to identify those relationships that they deemed most important. Mentoring is, after all, what the mentee says it is, and although mentors named here may include a wide range of experiences (e.g., one-shot mentored journal reviews conducted online; longer-term graduate advising relationships), the responses reflect relationships that mentees viewed as important regardless of their length or objective indicators of their intensity. Future research may wish to examine the unique networks created by these diverse relationships, the comparison between such networks, and the mentoring network noted here, as well as weight of mentoring relationship evidenced by satisfaction or quality ratings.

Further study of the networks within pediatric psychology will also want to continue to widen the pool of participants tapped. The present study examined the level of connectivity within the pediatric psychology field based on SPP listserv participation and responsiveness to the survey solicitation. The network that emerged therefore represents a subset of individuals within the field, and other methods of solicitation may produce identification of different relationships among other individuals (e.g., completion of survey as part of joining or renewing SPP membership). Additionally, given that many pediatric psychologists receive interdisciplinary clinical and research training, the current network is constrained to psychology connections even though in this field, many mentors might also be pediatricians, psychiatrists, nurses, and other professionals. It is also possible that providing space for listing up to 10 mentors may have encouraged individuals to list a greater number of mentors than if they had only been asked to list mentors in a free format, without a structured number. This methodology could have led to a greater sense of connectivity in the sense that listing more mentors would lead to a greater number of connections between individuals. On the other hand, it could also be argued that some people would have listed more than 10 mentors without imposed limitations. A few specific settings are strongly represented in the current sample, along with others. This result could indicate centrality of these particular settings to the field and the connections created through mentoring at a high rate. Of course, if people affiliated currently or previously with some sites were more responsive to the survey, an unintentional bias could have been introduced. On the other hand, the fact that mentees associated with a particular setting were so motivated may indicate a strength of connectivity of mentee to mentor.

The present study provides a snapshot of mentoring relationships in the field of pediatric psychology. Now that this snapshot has been provided, future research can seek to learn more about these mentoring relationships, such as mentor and mentee satisfaction with mentoring relationships or particular characteristics that enhance the benefits of a mentoring relationship. This future research could provide information to inform mentors and mentees of ways to maximize their satisfaction and professional development through mentoring relationships and serve as a guideline for mentoring relationships within the field of pediatric psychology.

**Summary**

The interconnectedness of the field of pediatric psychology provides ample opportunity for research and clinical collaboration. In the 1974 Society newsletter, the purpose of the field’s formal organization, SPP, was defined as a group involved with “exchanging information on clinical procedures and research, as well as to define the training standards for the pediatric psychologist.” This is no less true today and the fruitful clinical and research collaborations within the field are a product of these exchanges, including close and active mentoring relationships. The present report is an initial depiction of the vast and dynamic relationships present in the field. Furthermore, the topology present in pediatric psychology allows for important dynamical collaborations and can foster further development of the field in both clinical and research endeavors. We hope that those involved in the Society might be encouraged to add information to help develop this network further as part of the history section of SPP (http://www.societyofpediatricpsychology.org/history/). We anticipate having a mechanism to obtain ongoing input for updated depictions of relationships. With additions, we anticipate
that new networks will be formed, and the web of mentee–mentor relationships will expand, thereby strengthening the mature, yet ever-evolving connections in the field of pediatric psychology.

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