



Psychosocial Intervention

ISSN: 1132-0559

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Colegio Oficial de Psicólogos de Madrid  
España

Neal, Zachary P.; Watling Neal, Jennifer; Lawlor, Jennifer A.; Mills, Kristen J.  
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Psychosocial Intervention, vol. 24, núm. 3, 2015, pp. 177-184

Colegio Oficial de Psicólogos de Madrid  
Madrid, España

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## Small worlds or worlds apart? Using network theory to understand the research–practice gap<sup>☆</sup>



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### ARTICLE INFO

#### Article history:

Received 16 June 2015

Accepted 21 July 2015

Available online 19 September 2015

#### Keywords:

Social network

Small world

Research to practice gap

Information sharing

### ABSTRACT

The implementation of effective community interventions can be challenging for many reasons, including financial and time costs, lack of infrastructure, local contextual variations, and barriers to fidelity. But, prior to all of these is the challenge of limited information exchange between the researchers developing interventions and the practitioners implementing them, or the so-called research–practice gap. In this paper, we use network theory and review a dozen small world experiments to understand the research–practice gap, identifying three key lessons: (1) spatial and social distances are related to the severity of the gap, (2) social boundaries may lead to echo chambers and closed loops, and (3) wider gaps reduce the likelihood of successful information exchange. From these lessons, we recommend that researchers and practitioners should rely on the assistances of information brokers who know people they do not know and who are different from themselves.

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## ¿Mundos pequeños o mundos separados? Usando la teoría de redes para comprender la brecha investigación–práctica

### RESUMEN

La implementación de intervenciones comunitarias efectivas es un reto por muchas razones, que van desde los costes financieros y de tiempo a la falta de infraestructura, la diversidad de contextos locales y los obstáculos a la fidelidad. Pero antes de todo esto se cuenta el intercambio limitado de información entre los investigadores que desarrollan intervenciones y los profesionales que las implementan, que suele denominarse la “brecha entre la investigación y la práctica”. En este artículo utilizamos la teoría de redes y revisamos una docena de experimentos de mundo pequeño para comprender la brecha ciencia–práctica, obteniendo tres lecciones fundamentales: (1) las distancias espaciales y sociales se relacionan con la severidad de la brecha, (2) las fronteras sociales pueden traducirse en cámaras de eco y circuitos cerrados, y (3) las brechas más amplias reducen la probabilidad de un intercambio de información con éxito. A partir de estas lecciones se recomienda que los investigadores y los profesionales recurran a la ayuda de intermediarios que conocen a personas que ellos no conocen y que son diferentes a ellos.

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#### Palabras clave:

Red social

mundo pequeño

brecha de la investigación a la práctica

intercambio de información

The implementation of effective community interventions can be challenging for many reasons, including financial and time costs,

lack of infrastructure, local contextual variations, and barriers to fidelity (e.g., Castro, Barrera, & Martinez, 2004; Glasgow & Emmons, 2007; Glasgow, Lichtenstein, & Marcus, 2003; Wandersman et al., 2008). But, prior to all of these is the challenge of limited information exchange between the researchers developing interventions and the practitioners implementing them, or the so-called research–practice gap (e.g., Green, Ottoson, García, & Hiatt, 2009; Wandersman, 2003). From the perspective of practitioners, the gap is problematic because it means they lack (or have limited access

<sup>☆</sup> Prepared for Special Issue on Network Analysis for Social and Community Interventions in Psychosocial Intervention, edited by Isidro Maya Jariego & Daniel Holgado Ramos.

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to) information about evidence-based interventions, limiting their ability to engage in research-based practice (Wandersman, 2003). From the perspective of researchers, the gap is problematic because it means they lack (or have limited access to) information about the local context and indigenously developed solutions, limiting their ability to engage in practice-based research (Miller & Shinn, 2005). Accordingly, understanding why such a gap exists and identifying ways to bridge the gap is critical for both researchers and practitioners.

In this paper we show how network theory, and specifically the theory of small worlds, is useful for confronting the research-practice gap. Information is typically exchanged between researchers and practitioners not directly, but rather through a series of intermediaries or brokers (Cooper, Levin, & Campbell, 2009; Tseng, 2012). A research-practice gap exists when a communication chain like this does not exist to facilitate the exchange of information, or when the chain includes so many people and organizations that the information is distorted or delayed. Milgram (1967) was among the first to study such communication chains, concluding that despite geographic and social distance, any two strangers were connected by no more than six degrees of separation (i.e. five mutual acquaintances). This small world phenomenon has since been studied in a variety of contexts (see Table 1; c.f. Maya-Jariego, 2003). Insights from these studies are helpful for understanding and overcoming the research-practice gap in two ways. First, they identify the individual and contextual factors associated with shorter communication chains, which can facilitate faster and more efficient exchange of information between researchers and practitioners. Second, they highlight the most effective strategies for navigating communication networks, which can help researchers and practitioners to disseminate the information they have and search for the information they need.

We begin with a review of past discussions of the research-practice gap, focusing on the hypothesized role of interpersonal interactions, and introducing a conceptual framework that views communication between research and practice as composed of multiple processes. We then describe the small world phenomenon and Milgram's (1967) experimental search for an explanation. In the third section, we present a review of small world experiments conducted since 1967, concentrating on the lessons they offer in the context of linking researchers and practitioners. Finally, we conclude by discussing how small world network theory might be used to develop interventions or suggest strategies for closing the research-practice gap.

### The push and pull of research and practice

The research-practice gap is defined as the lack of translation of evidence-based interventions and policies to practice settings (Green et al., 2009; Wandersman, 2003). This gap is widely acknowledged as a critical problem across several fields including public health (e.g., Glasgow & Emmons, 2007; Green et al., 2009), psychology (e.g., Wandersman, 2003; Wandersman et al., 2008), education (e.g., Greenberg et al., 2003; Hallfors & Godette, 2002; Tseng, 2012), and medicine (e.g., Balas & Boren, 2000). Indeed, Wandersman (2003) noted that given its severity, the research-practice gap could more aptly be considered a "chasm" (p. 232). Over the past few decades, attention to the research-practice gap has led to the development of a plethora of frameworks designed to enhance the dissemination of research and the implementation of evidence-based interventions and policies (see Tabak, Khoong, Chambers, & Brownson, 2012 for review).

Many factors are associated with the research-practice gap, including characteristics of interventions (e.g., cost, lack of flexibility), target settings (e.g., instability, lack of time, organizational capacity), and research designs (e.g., unrepresentative samples,

lack of implementation data; Glasgow & Emmons, 2007; Glasgow et al., 2003). However, problems in the communication pipeline between researchers and practitioners are widely recognized as an important contributor to the research-practice gap (Green et al., 2009). The communication pipeline is viewed as involving multiple stages in which both researchers and practitioners play active roles: researchers *push* evidence-based information to practitioners via intentional dissemination and unintentional diffusion, while practitioners *pull* evidence-based information from researchers via search and acquisition efforts (Morrissey, Wandersman, Seybolt, Nation, Crusto, & Davino, 1997; Wandersman, 2003). As described by Green et al. (2009), problems in this pipeline arise due to geographic, professional, and personal social distances between researchers and practitioners:

"The gap is then partly one of social distance between the supply and the demand sides of science in geography as well as in organizational and professional or personal self-identities. Even at the local level, the town-gown social distance prevails because scientists are more oriented to the international audiences of other scientists for which they publish than to the needs of practitioners, policy makers, or the local public" (p. 155).

In short, the communication pipeline is compromised because researchers and practitioners are *worlds apart*, operating in separate geographies, under different organizational structures, and with different professional and personal goals.

Fixing the communication pipeline between researchers and practitioners requires attention to diffusion and dissemination frameworks. While diffusion denotes the unintentional spread of information about an intervention or policy, dissemination reflects more directional efforts to push this information toward the practice world (Green et al., 2009). Frameworks that focus on diffusion and dissemination are plentiful, with Tabak et al. (2012) describing 50 such frameworks in a recent narrative review.<sup>1</sup> One dominant theme found in diffusion and dissemination frameworks is the role of interpersonal interactions and communication networks. Some frameworks concentrate on how diffusion and dissemination processes are facilitated by interactions within practitioner communities through practitioner partnerships (e.g., Dreisinger et al., 2012; Elliott et al., 2003) and key opinion leaders (e.g., Dearing, Maibach, & Buller, 2006; Rogers, 1995). Others concentrate on the lack of direct interactions between researchers and practitioners and propose ways to strengthen these interactions (e.g., Anderson, Cosby, Swan, Moore, & Broekhaven, 1999; Baumbusch et al., 2008; Jacobson, Butterill, & Goering, 2003). Finally, several frameworks highlight the facilitative role of individual or organizational brokers that indirectly connect researchers and practitioners (e.g., Lomas, 1993; Nieva et al., 2005; Ward, House, & Hamer, 2009). Targeting these brokers is particularly promising for dissemination efforts because it capitalizes on pre-existing ties that bridge the research-practice gap (Cooper et al., 2009; Tseng, 2012).

Fig. 1 presents a conceptual framework that illustrates how multiple processes comprise communication between research and practice. The top panel (Fig. 1A) shows the conventional view in which information flows from researchers to practitioners. First, researchers engage in *development* and testing of interventions, generating information and evidence. The testing of interventions may occur through efficacy or effectiveness trials (e.g., Flay et al., 2005), but may also include alternate designs that might decrease barriers to practitioner adoption and implementation (Glasgow et al., 2003). Moving from left to right in the figure, the information

<sup>1</sup> Tabak et al. (2012) reviewed 61 models in total but 11 of these focused primarily or solely on implementation rather than diffusion or dissemination.

**Table 1**

Summary of small world experiment replications.

Study	Experiment		Findings		
	Starter(s)	Target(s)	Success	Length	Key variables
Travers and Milgram (1969)	76 NE residents	Stockbroker in Boston	24%	5.7	Distance Social class
	78 NE stockowners		31%	5.4	
	63 Boston residents		35%	4.4	
Lee (1969)	112 women	An abortionist	34.5%	2.83	
Korte and Milgram (1970)	458 white LA residents	9 white NYC residents	63%	5.5	Occupation Race
		9 black NYC residents	18%	5.9	
Guiot (1970)	52 French-Canadians in Montreal	English-speaking Ashkenazi vice principal of a Jewish day school near Montreal	84.62%	4.7	Facilitation Ethnicity
Erickson and Kringas (1975)	38 Ottawa residents	Political representatives	42.1%	>0.75	Occupation Age
Lundberg (1975)	30 utility workers	Top line worker	53.33%	3.18	Bureaucratization Work role
	30 utility workers	Top staff worker	56.66%	2.82	
	30 utility workers	Low line worker	56.66%	2.47	
	30 utility workers	Low staff worker	40.00%	2.08	
	87 electronics workers	Top line worker	67.81%	4.03	
	85 electronics workers	Top staff worker	63.53%	3.22	
	85 electronics workers	Low line worker	55.25%	3.45	
	85 electronics workers	Low staff worker	48.23%	3.44	
Shotland (1976)	110 faculty at MSU	Faculty at MSU	93.3%	2.22	Work role Rank
	110 students...	Faculty...	65.2%	4.26	
	110 administrators...	Faculty...	94.4%	1.30	
	110 faculty...	Students...	54.8%	5.55	
	110 students...	Students...	48.2%	4.11	
	110 administrators...	Students...	60.2%	4.26	
	110 faculty...	Administrators...	87.0%	1.63	
	110 students...	Administrators...	69.1%	3.69	
Weimann (1983)	46 Ashkenazi Jews	Ashkenazi Jews	72.26%	4.63	Ethnicity Friend vs. work
	33 Oriental Jews	Oriental Jews	84.84%	4.42	
	39 Ashkenazi Jews	Oriental Jews	53.84%	6.04	
	26 Oriental Jews	Ashkenazi Jews	61.53%	6.31	
Stevenson and Gilly (1991)	272 hospital workers	Person who could address a patient complaint	Not reported	3	Work role Profession
Dodds et al. (2003)	24,163 people recruited online	6 acquaintances of authors, 12 people recruited online	1.59%	4.05	Friend vs. work Gender Attrition
Killworth et al. (2006)	105 telephone survey interviewers	105 telephone survey interviewers	54.6%	3.23	None
Singh et al. (2010)	241 management consulting firm employees	26 experts in four content areas	44.40%	1.89	Gender Tenure Close to expert

or evidence developed by researchers is pushed out of the research community either intentionally via *dissemination* (e.g., publishing, offering workshops) or unintentionally via *diffusion* (e.g., word-of-mouth, media coverage). While it is theoretically possible for this information to disseminate or diffuse directly to practitioners, it is unlikely given the social distances between researchers and practitioners described by Green et al. (2009). Instead, brokers often play a critical role by facilitating the transfer of information from researchers to practitioners. Practitioners may *acquire* information from individual or organizational brokers as they push information outward. For example, Scott and Jabbar (2014) found that certain intermediary organizations like think tanks, advocacy groups, and parent coalitions actively promote information generated by researchers to U.S. based educational practitioners. In contrast, practitioners may also *search* for information from individual or organizational brokers, thereby actively pulling information in. For example, U.S. based educational practitioners often frequent the Institute for Education Science's *What Works Clearinghouse* to search for evidence-based instructional and social skills

programs. Once practitioners obtain useful information via acquisition or search, they can choose to adopt an intervention and begin the process of *implementation*.

It is important to note that information can also flow from practitioners to researchers, as shown in the bottom panel (Fig. 1B). In the case of indigenously developed interventions and practices, the information is developed by practitioners or community members, not by researchers (Miller & Shinn, 2005). This information then spreads, typically through an unintentional diffusion process, although there may be instances of communities that purposefully seek to disseminate their homegrown practices. Researchers may acquire this information as it is pushed out by brokers, which might include local newspapers and other media outlets that describe a community's success at addressing its own issues. Researchers may also search for this information, for example, by explicitly seeking to inform their own work by first looking at what communities and practitioners are already doing (e.g., practice-based research).

This is, of course, a highly abstracted model, but is designed to highlight the multiple processes involved in the transfer of

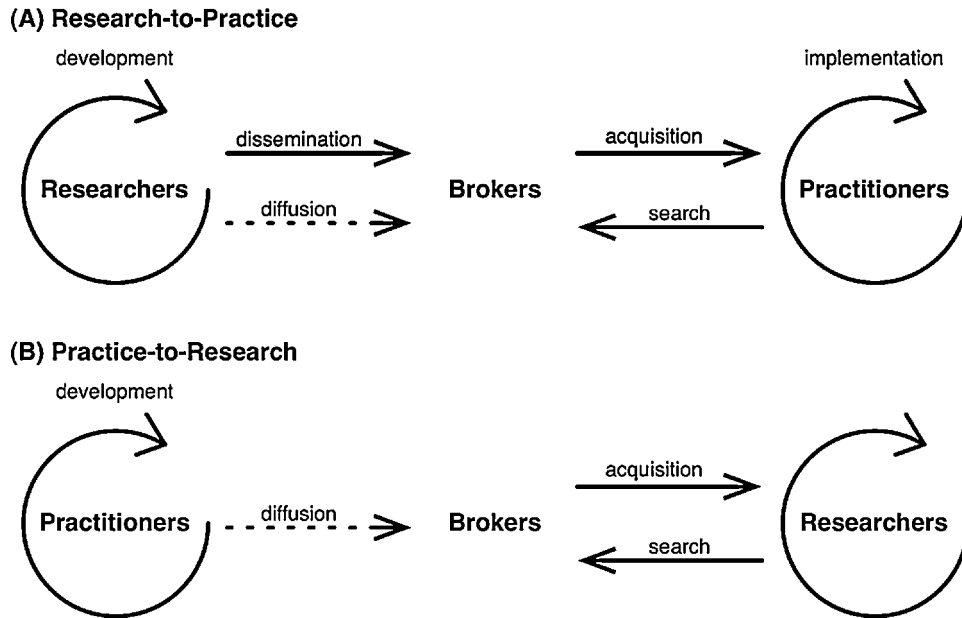


Fig. 1. Linking research and practice.

information between researchers and practitioners. These processes can be active (dissemination and search) or passive (diffusion and acquisition), but the transfer of information in either case hinges on the existence of one or more brokers. A research-practice gap occurs when these brokers are absent. For example, a researcher may disseminate findings in an academic journal, but without a broker to translate the findings or distribute a summary of the article, practitioners are unlikely to acquire this information. Likewise, a practitioner may search for information, but without a broker to assist in the search, they are unlikely to find what they are looking for. Thus, overcoming the research-practice gap requires understanding when such brokers exist to bridge between the separate worlds of researchers and practitioners. Small world experiments, initiated by [Milgram \(1967\)](#), offer the potential for improving this understanding.

### Stanley Milgram's other experiment

Among psychologists, Stanley Milgram is perhaps best known for his controversial [1963](#) study of obedience, which involved testing subjects' willingness to follow an authority figure's orders to deliver painful electric shocks to another person. However, a few years later he began a series of experiments designed to explain the small world phenomenon, and which subsequently gave rise to the popular notion of six degrees of separation ([Milgram, 1967](#)). The small world phenomenon refers to the experience of two strangers discovering in the course of conversation that they are linked by a series of mutual acquaintances (i.e. a friend of a friend), at which point, one of them remarks, "Gee, it's a small world." Milgram framed this phenomenon as the "Small World Problem" because it seemed impossible that two strangers would be linked, given the size of the world's population (in 1967) and the fact that most individuals' social circles are relatively closed (i.e. my friends are mostly friends with each other).

To investigate this phenomenon, he developed what has come to be known as the small world experiment. In its abstract form, the small world experiment asks a "starter" to deliver a message to a stranger, the "target," by passing it only through personal acquaintances. For example, a starter might first pass the message to his neighbor, who passes it to her boss, who finally passes it to the

target. Of particular interest is whether the message successfully reaches the target, and when it does, the number of intermediate contacts that participated in the chain. In this simple example, the starter and target, despite being strangers, were separated by just two intermediate acquaintances: the neighbor and the boss.

The first full-scale small world experiment asked a sample of 296 starters living in Nebraska and the Boston area to deliver a message to a stockbroker living in Sharon, Massachusetts, who served as the target ([Travers & Milgram, 1969](#)).<sup>2</sup> Each starter was provided a package that described the study, identified the target person, and contained several tracer postcards. The starters were instructed to mail the package to the target if he/she knew the target on a personal basis, and otherwise to mail the package to a personal acquaintance who was more likely to know the target. Subsequent recipients of the package were asked to follow the same instructions. At each stage, the sender was also asked to send a tracer postcard to the researchers, which allowed them to track the package's progress.

Of the 217 starting persons who participated in the experiment, 64 were able to deliver the package to the target, requiring an average of 5.2 intermediate acquaintances. However, the average length of a completed chain varied by the spatial and social distance between the starting person and target. Chains started by random Nebraska residents were the longest (5.7), while those started by Nebraska stockholders (5.4) and by those living in Boston (4.4) were shorter. Additionally, some intermediaries appeared in multiple chains, in a process the researchers described as funneling. For example, 16 of the packages that reached the target did so via just one of the target's neighbors. Indeed, nearly half of the successful chains were successful thanks to three particularly critical intermediaries.

The key elements of the small world experiment can readily be translated to the research-practice gap context ([Meline & Paradiso, 2003](#)). In the conventional view of information flowing from researchers to practitioners, the researchers are the starters and the practitioners are the targets. However, the roles may be reversed in

<sup>2</sup> A preliminary small world experiment asked a sample of starting persons living in Kansas to deliver a message to the wife of a divinity school student living in Cambridge, Massachusetts.



the case of practice-based research where information flows from practitioners and indigenous communities to researchers (Miller & Shinn, 2005), and in the case where practitioners are actively searching for information from researchers. In either case, it is rare that a researcher and a practitioner are personally acquainted, and more likely that information flows between them via one or more brokers. Overcoming the research-practice gap requires ensuring that brokers exist who can facilitate the flow of information, and that the number of brokers required is relatively small. Travers and Milgram's (1969) key findings also translate into plausible hypotheses concerning the success and length of these information transfer chains. First, just as the chains were shorter for Boston starters than for Nebraska starters, likewise the research-practice gap will likely be smaller for researchers and practitioners who live in the same area. Second, just as the chains to a stockbroker were shorter for Nebraska stockholders than for general Nebraska residents, likewise the research-practice gap will likely be smaller for researchers who have engaged in practice (e.g., through an internship or practicum experience), or practitioners who have engaged in research (e.g., through a university–community partnership). Finally, just as a large number of packages were delivered to the target stockbroker by his neighbor, likewise there are likely a few key intermediaries who are particularly critical for bridging the research-practice gap. Such intermediaries may be especially important in the research-practice gap context because, in addition to serving as brokers that facilitate information exchange, they can also serve as gatekeepers that selectively allow only certain pieces of information through.

### Small world experiments: findings and lessons

Milgram's initial small world experiment offers an experimental and conceptual framework for thinking about the research-practice gap. But, this experiment has been replicated using different starters and targets several times. In this section and in Table 1, we briefly summarize the methods and findings of these subsequent small world experiments, drawing out three key lessons that can teach us about the research-practice gap. Our review focuses only on studies that replicated the key features of Milgram's small world experiment, but excludes studies that used elements of the method for other purposes (e.g., Bochner, Buker, and McLeod, 1976 link-tracing approach). For a comprehensive review of all small worlds research, see Schnettler (2009).

The "starter" and "target" columns in Table 1 identify the settings and populations involved in replications of Milgram's small world experiment, and highlight two key ways that these experiments have differed. First, some small world experiments draw starters and targets from the same population, like Killworth, McCarty, Bernard, and House's (2006) study of telephone survey interviewers, while others draw starters and targets come from distinctly different groups, like Lee's (1969) study of women searching for abortionists or Erickson and Kringas' (1975) study of residents contacting politicians. The exchange of information between researchers and practitioners more closely resembles the latter case, because researchers and practitioners often represent distinct populations, each embedded in their own settings and with their own professional and personal goals (Green et al., 2009).

Second, some small world experiments focus on information exchange in a specific closed setting, like Shotland's (1976) study of communication at Michigan State University, while others examine information exchange in society at large, like Dodds, Muhamad, and Watts (2003) large internet-based study. Both types of situations may be relevant to the research-practice gap because the researchers and practitioners who need to exchange information may both be located in the same closed setting (e.g., teachers and

in-district research staff in a large urban school district), but may also be situated in the larger society (e.g., a community mental health professional in the U.S., and a mental health researcher at an institution in Spain). Focusing on this distinction, Killworth et al. (2006) contend that starters will more successfully reach targets in open systems than in closed systems. In closed systems, starters are likely to rely on their (possibly incorrect) understandings of the system's structure to reach targets. For example, a teacher seeking information from an in-district researcher may, based on her knowledge of the district's organizational chart, think that contacting the district's office of professional development is the appropriate next step, when in reality contacting the research office directly would be more useful. In open systems, starters "are more aware that they cannot comprehend the structure, and so use only attributes of their acquaintances in an attempt. . .[at] completing the chain" (p. 95). For example, when a community mental health professional seeks information, because there is no global organizational chart of mental health researchers to potentially mislead her initial search, she can instead focus on the attributes of the people she knows (e.g., "Is my colleague likely to know any mental health researchers?").

*Lesson 1: Spatial and social distances are related to the length and success of chains.* The success and length columns of Table 1 show the percentage of chains initiated by starters that successfully reached the target, and the average number of intermediary brokers involved in these chains. Small world experiments frequently seek not only to identify these values, but also to understand why some chains are successful while others are not, or why some successful chains are shorter than others. The final column of the table identifies some of the key variables that explain these findings. In most cases, the explanatory variables capture various aspects of distance: chains are more likely successful and are shorter when the starter and target are separated by small spatial distance (i.e. they live nearby) and small social distance (e.g., same ethnicity, same race, same rank). However, a few other explanatory variables are noteworthy as well. Guiot (1970) attributed the high rate of success to his experimental design, in which the researcher himself contacted participants as the message was forwarded, rather than leaving the task of forwarding the message up to the participants themselves. Similarly, Dodds et al. (2003) attribute their low rate of success to attrition among the intermediaries; there was little incentive to participate, and thus most chains terminated early. Finally, Lundberg (1975) linked differing success rates to differing levels of bureaucratization in two settings: the utility company had a strict hierarchy and policy manual that hindered informal contacts, while the electronics company managers were "proud of the practice of using first names among all personnel" (p. 209).

Reduction of a research-practice gap would involve maximizing the likelihood that information will move from a researcher to a practitioner (or vice versa; i.e. success) and minimizing the number of brokers necessary to facilitate this transfer (i.e. length). Factors of spatial and social distance are likely influential in this context. That is, the research-practice gap is likely narrower when researchers and practitioners work in the same community, and when they share socio-demographic features. While this remains a hypothesis to be tested, Singh, Hansen, and Podolny's (2010) study of consulting firm employees (i.e. practitioners) seeking information from content area experts (i.e. researchers) offers more concrete insight into factors affecting the success and length of chains in this context. They found significant inequality among employees in their ability to contact experts and obtain information. Specifically, they found that newer employees were at a disadvantage, both because they "had lower cognitive awareness about who knows what" (p. 1433) and were more likely to turn for help to others who were similarly peripheral to the organization. This suggests that the research-practice gap may be less severe for those who have

been researchers or practitioners for some time, but also highlights the potential for subtle inequalities in who might experience the disadvantages of a research–practice gap. For example, this finding might also suggest the research–practice gap could be more severe in areas that are dominated by researchers and practitioners who are newer to their fields.

Many of the small world experiments shown in Table 1 focus on starter–target pairs that require crossing social boundaries including race (Korte & Milgram, 1970), organizational role (Shotland, 1976), and ethnicity (Weimann, 1983). In each case, chains were more often successful and were shorter when the starter and target came from the same group, than when the starter and target came from different groups. In this latter case, a successful chain requires crossing the social boundary from one group to another at some point. For example, a successful chain from a white starter to a black target in Korte and Milgram's (1970) experiment requires, at some point, that a white participant passed the message to a black participant. Investigating this boundary crossing requirement, Weimann (1983) found that “in mixed chains, where at least one cross-[group] link is forced, it is delayed by the participants until the stage when it is unavoidable, [but] once a gatekeeper is found, the chances for successful completion rise significantly” (p. 298). That is, effective communication between starters and targets from different groups hinges on that critical moment when the message jumps from one group to another. This phenomenon has a clear analog in the research–practice gap context because the researcher and practitioner communities often operate as different social groups. The successful transmission of information from a researcher to a practitioner requires that at some point the information leaves the researcher community, and enters the practitioner community.

*Lesson 2: Social boundaries may lead to echo chambers or closed loops that hinder chain success.* Some small world experiments have identified the risk of an “echo chamber” when a message fails to cross a social boundary. In their study of hospital workers' attempting to locate a person capable of handling a patient complaint, Stevenson and Gilly (1991) expected “managers, as the exemplars of formal procedure, to forward folders directly to formally designated complaint handlers” (p. 921), but instead found that “managers relied more on . . . other managers rather than formal problem solvers, and tended to keep problems within their own professions” (p. 926). That is, once a patient complaint landed in the hands of a manager, it often simply circulated among a group of other managers without making progress toward someone who could address the complaint. In a different context, Killworth et al. (2006) found that starters could not reach their targets because the messages would get stuck in these types of closed loops in nearly 24% of all chains. This is also frequently observed in both researcher and practitioner communities: researchers regularly publish their findings in research journals that are available to and read by only other researchers, while practitioners seek advice from other practitioners. More generally, sending information to, or receiving information from, another member of one's own community serves to exacerbate the research–practice gap.

*Lesson 3: The longer the chain, the lower the likelihood of success.* The risk of attrition represents still another challenge to transferring information from a starter to a target via a chain of intermediary brokers. At each step of a message's journey toward the target, the current message holder must decide whether to pass the message along or not. As a result, long chains have a lower likelihood of success because they involve more opportunities for the chain to prematurely terminate. This also means that the observed chain lengths reported in Table 1 are systematic underestimates of the actual separation between the starters and targets because they include only successful, and thus likely shorter, chains. Some small world studies have attempted to use statistical models to determine

the actual mean chain length in the absence of attrition. For example, while the completed chains observed by Singh et al. (2010) included 1.89 brokers on average, if chains had not prematurely terminated due to attrition, they would have been more than 25% longer and included an average of 2.37 brokers. Dodds et al. (2003) suggest that attrition may arise when participants lack incentives to help with the transfer of information, noting that “if individuals searching for remote targets do not have sufficient incentives to proceed, the small-world hypothesis will not appear to hold, but that even a slight increase in incentives can render social searches successful under broad conditions” (p. 828). This might have an important implication for the research–practice gap. If researchers do not have a clearly defined practitioner audience to serve as a target for their findings, or if practitioners do not have a clearly defined information need to serve as a target for their search, the gap is likely to persist because the ambiguity of the task of facilitating information exchange will deter all but the most dedicated brokers. That is, if brokers do not know what they are brokering, they are unlikely to help.

### Building a small world of researchers and practitioners

Milgram (1967) initially framed his small world experiment as a way to gain insight into the small world problem: how is it possible that, although the people we know mostly also know each other, which makes our social world feel small, we are nonetheless linked to the rest of the world by just a few intermediaries? For example, from the perspective of a white Angeleno in Korte and Milgram's (1970) study, the world is small and local: he knows mostly other white Angelenos, who live in the same area, visit the same shops and restaurants, and know each other. Likewise from the perspective of a black New Yorker in their study, the world is small and local: she knows mostly other black New Yorkers, who live in the same area, visit the same shops and restaurants, and know each other. However, despite their perceptions of living in small and bounded communities, the white Angeleno and black New Yorker are actually quite socially close, separated by just 6 mutual acquaintances. The many small world experiments confirmed this problem – the world seems small, but actually is big – but did not offer an answer to the apparent paradox.

To resolve the paradox, it is helpful to consider a couple different kinds of networks. At the one extreme, imagine a network in which people form closed communities within which everyone knows everyone else, but between which there is no communication. In the research–practice context, this is a worst-case scenario: researchers talk to other researchers, and practitioners talk to other practitioners, but they never talk to each other (Fig. 2A). In this kind of network structure, the world seems small to each individual, but it is also fragmented. At the other extreme, imagine a network in which people do not form clear communities, but rather know and talk to others randomly. In the research–practice context, this may seem ideal, with researchers and practitioners indiscriminately engaging with one another, but it does not allow researchers or practitioners to form their own communities, within which they might develop professional standards and cultivate collaborative relationships (Fig. 2C). In this kind of network structure, the world is very big because each person is just a few links from everyone else, but it is also disorganized.

Watts and Strogatz (1998) found that if a small number of random links are added to a network otherwise composed of closed communities, a unique new type of structure – a small world network – is formed. In a small world network, people still form relatively distinct communities that allow the world to seem small, but the few random links between these communities also mean the world is big and people are separated by just a few links.

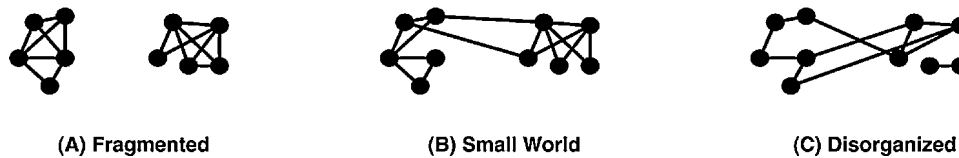


Fig. 2. Small world networks.

Interestingly, Watts and Strogatz (1998) discovered that many real world networks have this type of structure, and the structure of communication ties among researchers and practitioners is likely no exception. Researchers and practitioners each have relatively dense communities of their own, but just a few random linkages between these two communities dramatically reduce the gap between them (Fig. 2B). Within the communities, researchers and practitioners are able to form strong collaborative bonds and develop professional norms and standards, while between the communities they are able to efficiently share information through just a few intermediate brokers.

It is likely that the research-practice world is structured like a small world network, but this alone does not solve the research-practice gap. It is still necessary for researchers and practitioners to *navigate* this network as they attempt to push information out through dissemination efforts and pull information in through search efforts. That is, for example, although it might be possible for a practitioner to pull information in from a researcher via a (small) series of brokers, the practitioner does not necessarily know which brokers will be most effective for this purpose (Kleinberg, 2000). When searching for information, a starter may or may not know the exact identity of the target, but they certainly do not know the global structure of the communication network. Instead, a starter has only local information about his or her own network, and thus must rely on search strategies intended to help find information efficiently. Among the simplest strategies is the high-degree search, which suggests that when a practitioner is looking for a piece of research, or a researcher is trying to get a piece of research to practitioners, he or she should seek the assistance of a broker who knows lots of people. Despite the intuitive appeal of such an approach, it is often not useful for finding the shortest chain toward a target (Adamic & Adar, 2005), and thus is likely not an effective strategy for reducing the research-practice gap.

A second strategy that is widely used, but also nearly always ineffective, is a homophily search in which the starter turns for assistance to a broker who is like him or herself. This strategy is particularly common with respect to gender and race, with starters and subsequent brokers in the chain turning to others with the same demographic characteristics as themselves. But, it is also applied with respect to work roles and rank, where the risk of a research-practice gap is clear. Consistent with Lessons 1 and 2 reviewed above, a homophily search may lead to unsuccessful chains between researchers and practitioners, as well as echo chambers. If a practitioner seeking a piece of research turns to another practitioner, who then turns to another practitioner, the search for information spirals around within the practitioner community with little hope of reaching the target. The same is true for a researcher seeking to disseminate a piece of research, but who talks to another researcher, who in turn talks to another researcher.

Although the high-degree and homophily search strategies may not reduce, and may even exacerbate, the research-practice gap, they also hint at alternate strategies that may be more effective. First, rather than turning to a broker who knows lots of people, *researchers and practitioners should seek assistance from brokers who know people they do not know*. The feature of brokers that makes them critical in closing the gap is not how many people they know, but rather whom they know. Brokers that know different people,

that is, whose social circles do not overlap with the information seeker, provide a bridge to other parts of the social world. Second, rather than turning to colleagues and coworkers, *researchers and practitioners should seek assistance from brokers that are different from themselves*. To be sure, this might be a particularly challenging search strategy to adopt because colleagues and coworkers are a natural source of information and advice, but they are also likely to be a source for redundant information that merely confirms the seeker's initial beliefs. Turning to different others for help in pushing or pulling information facilitates breaking out of one's own closed community and bridging into other communities, including the target's. These two strategies may help bridge social and spatial distances that limit successful searches (Lesson 1), reduce the potential for echo chambers (Lesson 2), and reduce the number of brokers needed to link researchers and practitioners (Lesson 3).

The fact that communications among researchers and practitioners likely take the form of a small world network structure means that there are relatively short chains of intermediate brokers through which researchers and practitioners can exchange information. Thus, the research-practice gap can, at least in principle, be overcome. Actually overcoming the gap requires finding these short chains, which can be aided by consciously eschewing some common strategies (e.g., degree, homophily) and consciously adopting alternate strategies for deciding where to seek assistance when trying to push information out or pull information in. These conclusions are informed by a wealth of research on the small world phenomenon that span many different contexts and more than five decades, but to date these phenomena and search strategies have not been studied specifically in a researcher-practitioner context. Thus, in addition to sketching a promising solution for the research-practice gap, these ideas also identify an important direction for future research. Future research on bridging the research-practice gap through a chain of intermediaries may also benefit from investigating the composition of those chains, exploring for example, the kinds of individuals or organizations that frequently appear in these chains and the types of brokerage in which they are involved (e.g. Gould & Fernandez, 1989; Neal, Neal, Kornbluh, Mills, & Lawlor, in press).

### Conflict of interest

The authors of this article declare no conflict of interest.

### Financial support

This research was supported by an Officer's Research Award (#182241) and Use of Research Evidence award (#183010) from the William T. Grant Foundation.

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