Learning From Neighbors:

Social Learning About Child Feeding During Diarrheal Episodes

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ABSTRACT. Population-level behavior change requires information and new ideas that spread beyond the confines of targeted beneficiaries of programmatic interventions. Using Demographic and Health Surveys (DHS) data from two countries (Bolivia and Madagascar), we examine mothers' ability to correctly respond to the question regarding whether a child with diarrhea should be given more fluids, the same amount of fluids, or less fluids. Controlling for usual correlates—including women's education, media exposure, number of children, age, and household economic status—we find that the fraction of a woman's neighbors (that is, those in the same sampling cluster) that answer correctly substantially raises the likelihood that the woman herself will also respond correctly. With a single cross section it is difficult to determine whether this represents direct social learning or some other cluster specific effect, for example, that all neighbors were exposed to the same conditions. However, there are two pieces of evidence that strongly suggest direct social learning as an explanation. First, the impact is much smaller and (in Bolivia) insignificant in urban areas. Second, controlling for all other cluster characteristics—including average education and wealth—does not drive out the direct cluster less household knowledge term. Broad-based impact depends in part upon development professionals' ability to understand and encourage knowledge diffusion and social learning about optimal health behaviors.

Introduction

Population-level improvements in health driven by programmatic interventions depend not only upon program beneficiaries' acceptance of new ideas about behaviors, but also upon the extent to which beneficiaries spread information to the general population. Information transmission occurs through a variety of channels including behavior change, communication activities mounted by public and private entities, and interpersonal communication. While policy makers and program planners are able to design and disseminate information to target audiences, they have generally been less successful at identifying and capitalizing upon social networks to bring about large-scale diffusion of information and behavior change. This may be so because social networks and the diffusion of innovations are poorly understood (Goldman, Pebley and Beckett 2001 note there has been little demographic research on the diffusion of innovative health ideas in "Southern" countries). Development practitioners simply assume that program beneficiaries will readily share new health information and hence programs often fail to explicitly encourage direct program participants to share new health knowledge with others who do not directly participate in programs. In this paper we examine the issue of diffusion of health *information* (not yet behavior, but that will come) and show that women whose neighbors possess correct information about how much children should drink during episodes of diarrhea are themselves much more likely to be knowledgeable about fluid intake during illness episodes. We also show this association persists even after adjusting for such individual and household correlates as maternal age, education media exposure, and household economic status and after controlling for cluster level observables.

I) Framework and review of the literature

This section lays the groundwork for examining the impact of neighbor's knowledge on one's own knowledge or beliefs by some simple definitions and a review of the existing literature on diffusion of information and innovation/adoption of practices.

I.A) Framework

While we are interested in the broad question of how individuals come to adopt useful innovations on the basis of new information and what role direct, individual-to-individual transmission of new information plays in changing practices, we begin with a much narrower question. The narrower, empirically feasible, question we address is how individuals' *reported* beliefs about a *question of fact* are related to the reported beliefs of their neighbors. Even for this limited objective we need a framework for describing how individuals' beliefs are affected by the receipt of messages from various sources.

Beliefs and messages. If we start with a simple factual proposition X, we can characterize the belief of person P in proposition X by an intensity score $B^P(X)$ that ranges from zero (maximal certainty that X is false) to 1 (maximal certainty that X is true), with 0.5 implying no belief at all. Person P's beliefs will depend on his or her experience (E) and on messages (M) from various sources. The extent to which messages will change person P's beliefs depends on the credibility for P of source J with respect to the topic area of X:

$$B^P(X(E,\mathbf{B},\mathbf{M}) \mid M^J(X)) - B^P(X(E,\mathbf{B},\mathbf{M})) = f(\mathit{credibility}\ J, Z)$$

Suppose further that individuals report that their belief exceeds some threshold, B. The likelihood that P learns "X is true" via direct social connections depends on the likelihood of the true message and the credibility of the source. The likelihood that someone to

whom P is socially connected transmits a true message about X to P is a function of the number of connections P has, the intensity of the connection (where intensity is measured by the frequency of communication), and the likelihood that the person to whom P is connected possesses the correct information. Person P's belief in the message is also a function of the credibility that P places in the source of the message with regard to the topic of X.

The source of information also affects individuals' exposure to and use of new knowledge. Impersonal sources of information, including mass media, generally reach more individuals and can be particularly effective in creating knowledge and establishing social norms. Alternatively, interpersonal communication such as support groups and household visits by health promoters, as well as other forms of interpersonal contact, is likely to reach fewer people but may be more strongly associated with improved knowledge and health behaviors (Goldman et al., 2001).

From belief to practices. Accepting information and adopting new behaviors are complex processes that, according to diffusion theory include knowledge, persuasion, decision-making, implementation and confirmation (Rogers, 1995). Numerous studies indicate that knowledge does not necessarily translate into practice (Pinfold, 1999; Stanton and Clemens, 1987; Curtis et al., 1993). In a study about HIV/AIDS prevention among US youth, Middlestadt and colleagues (1996) identified a range of determinants of consistent condom use—including perceptions about the consequences of using a condom, facilitators and barriers to condom use, and social norms. As Rogers points out (1995), consequences are the perceived changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation. Historically, program

planners and implementers, including change agents at the field level, have assumed that the consequences of engaging in a given behavior will be perceived as positive. Consequently, individuals' perceptions of consequences are often ignored (Rogers, 1995). Additionally, consequences may be difficult to measure. Likewise, survey research methods may be inappropriate for fully assessing the range of consequences associated with engaging in a particular behavior.

Most individuals evaluate an innovation not on the basis of scientific research by experts, but through subjective evaluations of near-peers who have adopted innovations (Rogers, 1995). Previous research (Rogers, 1995) indicates that individuals are more likely to hear about information if their networks are large, are centrally located within local social networks, and are composed of weak ties with others who are differently positioned in the social structure. In contrast, members of dense networks usually receive little information from outside sources. Because they often hear of innovations later, they are generally late adopters (Valente, 1995).

Even if individuals possess correct information, they may not practice a given behavior if the innovation itself is difficult to understand and not "trialable." Moreover, if the results of trying an innovation are not clearly visible to others, individuals are less likely to attempt a new practice. In our case, the innovation (giving the same amount or more liquids during episodes of diarrhea) is easy to understand and trialable, but results are difficult to monitor.

I.B) Empirical Literature on social diffusion of information

Several authors (Valente, 1995; Rogers, 1995; Watts, 1999) provide an extensive review of the literature on diffusion of information. In brief, numerous traditions—

including anthropology, sociology, public health, marketing, and geography—have contributed to a greater understanding of information-sharing about new ideas. Much of the anthropological literature focuses on the intercultural transfer of technology and the consequences for societies of adopting new innovations. Historically, sociology has concentrated on the innovation-decision process, roles of communication sources in conveying information, differing rates of adoption and the characteristics of various adopter categories. More than 50 years after publication, a study on the diffusion of hybrid corn in Iowa (Ryan and Gross, 1950) continues to influence research methods and thinking about the diffusion of innovations. Findings from public health research on diffusion of innovations indicate that early adopters transmit experiences through interpersonal networks and influence the rate of adoption of later adopters.

A considerable subset of public health literature focuses on information-sharing focuses on family planning. Berelson and Freedman's classic study in Taiwan (1964) points to the importance of interpersonal communication (including home visits by change agents) in increasing the use of family planning methods (and the IUD in particular) and in reducing pregnancy rates. Their research underlines the importance of developing a critical mass of individuals who can generate personal motivation and social support for adoption of innovations. The marketing literature distinguishes between the influences of mass media and interpersonal, word-of-mouth contact. Marketing tools forecast adoption of innovations. Social marketing uses marketing to encourage individuals to purchase products such as oral rehydration salts and family planning methods (including condoms) and to adopt other healthy behaviors. Among other contributions, geography elucidates how space affects diffusion. Given the breadth of

research on family planning and the relevance of changes in health practices to improving liquid intake during episodes of diarrhea, we briefly review findings from studies in both disciplines.

Family Planning. Rogers and Kincaid (1981) report that in Korea, individuals whose discussion networks largely adopted contraception were themselves far more likely to contracept than individuals whose networks had not tried family planning. Montgomery and Casterline (1993) study the evolution of attitudes towards family planning and show that reference groups play an important role in the spread of information and women's adoption of family planning methods. Similarly, Casterline and colleagues (19XX) demonstrate that women's use of a particular family planning method is strongly influenced by use of that method in the same village. While these studies point to the importance of social influences, it is not clear whether the effect was via social contacts who conveyed factual information or whether the social contacts modified preferences directly, for example, by demonstrating the benefits of smaller families. In the case of Taiwan, the evidence is not clear; however, Montgomery and Casterline (1993) conjecture that information about new forms of fertility control must have been the dominant theme initially, followed by the social and economic benefits of smaller families.

It may be that couples' level of discussion with reference group members—as opposed to their perceptions of the contraceptive behavior of the reference group—plays a greater role in influencing beliefs and behaviors. Evidence from Kenya (Rutenberg and Watkins, 1997) indicates that the discussions women have with others about family planning are detailed and of sufficient depth that individuals learn of others' opinion

about and use of family planning. Rutenberg and Watkins (1997) also point out that the source of information and social proximity are important determinants of whether women use family planning. In Kenya, nurses are seen as crucial resources for complicated technical information clients need in order to use methods correctly. However, providers are socially distant from rural women. As a result, women often consult women whose bodies and circumstances are more like their own.

Hygiene Practices. In contrast to the successful introduction of the intrauterine device in Taiwan, several early seminal studies on hygiene indicate that innovative behaviors did not become widely diffused. Wellin (1955) describes the efforts of change agents who worked intensively for two years to encourage Peruvian mothers to boil their water. Change agents were only able to convince 5% of caregivers to boil their water. Wellin (1955) conjectures that culture played an important part in discouraging local residents from boiling water. Boiled water was considered “hot” and consequently, appropriate only for the sickly. A more recent study from Egypt (Belasco, 1989) suggests that few women used pumps to obtain clean water, opting instead for dirty canal water. Women failed to adopt this technological innovation for a variety of reasons. Not nearly as many pumps were installed as originally promised. Pumps broke and were not fixed. Water had a “chemical” or “medicinal” taste to users and was perceived to weaken sex drive and contribute to infertility. Additionally, obtaining water meant waiting in long lines.

In a study on communication channels for promoting hygiene behaviors in Thailand, Pinfold (1999) found that school children were the only message channel that showed a significant association with behavior change. Pinfold (1999) also notes that that

some villages had a particularly strong sense of community spirit and that in such villages, the task of promoting hygiene behaviors was relatively easy.

In a study on the diffusion of ideas about personal hygiene in Guatemala, Goldman and colleagues (2001) distinguish between interpersonal and impersonal contacts as mechanisms for sharing information and influencing norms. Results from their research provide evidence of diffusion through social contacts, particularly through interpersonal exchanges. For example, interpersonal ties (including whether the respondent had relatives abroad or in the capital and whether the respondent or a family member was active in community organizations) were important determinants of beliefs about hygiene and contamination, even after adjusting for women's education, socioeconomic status, ethnicity, and a range of community characteristics, including migration abroad, bus service and distance to Guatemala City. Goldman et al (2001) also found that interpersonal social contacts both within and outside of the community significantly increased the likelihood that women attribute diarrhea to contamination (pathogen-related) but not to hygiene (dirtiness). With respect to the impact of social contacts on actual hygiene behaviors, only one measure of interpersonal contact (having relatives abroad or in Guatemala City) was associated with observed cleanliness. However, a range of community-level variables (regular bus service, living in larger areas and residing in areas closer to Guatemala City) were linked with cleanliness.

I.C) The Programmatic Literature on Diffusion of Information

Results from several applied research studies indicate minimal spread of information or subsequent behavior change. For example, in a study on the impact of Freedom from Hunger's "credit with education" strategy in Ghana, MkNelly and

Dunford (1998) found little evidence suggesting spillover of behaviors between members of credit groups and women from the same villages who did not participate. Non-participants from program communities were about as likely as controls to be knowledgeable about a range of health behaviors and to practice those behaviors. On the other hand, credit group members were considerably more likely than non-participants from program communities and controls to practice optimal behaviors including giving colostrum, waiting to introduce water and watery foods into the child's diet, using a bottle to feed their infants, and giving oral rehydration salts (ORS) solution to children suffering from diarrhea. Results from a Save the Children study in Mali (Castle, 1997) provide similar results. Non-participants from program communities and controls were about as likely to hear about and be able to recite the recipe for ORS, to give ORS, to know the causes of malaria and to practice good hygiene. On the other hand, children who participated in Save the Children's village school program were considerably more likely to possess correct information about each of these topics and to practice optimal health behaviors. Findings from a study on the impact of mother-to-mother support groups in Guatemala by Dearden and colleagues (2002) indicate that after approximately one year, La Leche League staff was able to improve rates of exclusive breastfeeding among mothers who directly participated in League activities. However, there were few differences in breastfeeding behaviors—including any breastfeeding, current breastfeeding, exclusive breastfeeding, and bottle use—between program and control communities overall, suggesting little spillover effect, at least in the short-term.

II. Knowledge about response to diarrhea

The standard Demographic and Health Surveys (DHS) contain a hypothetical question: "When a child has diarrhea, should one give him a smaller amount of liquid, the same amount, or more liquids than usual?"[1] The possible (prompted) answers are "more fluids", "less fluids", "same amount of fluids" and "don't know." This question is excellent for examining knowledge diffusion and social learning for a number of reasons.

First, diarrhea is a common condition and is the cause of considerable morbidity (including malnutrition) and hence, given the high prevalence of diarrhea, the correct answer to the question is reasonably important to each caregiver. Second, there is a paucity of research regarding information sharing and health in Southern ("developing") countries. Third, little is known about the extent to which caregivers share correct information about infant and child feeding in general or if they share best practices for ensuring that children experiencing diarrhea stay well-nourished.

Diarrhea remains the number one cause of death to children 1 to 60 months of age, contributing to 22% of all deaths worldwide (Black, Morris, Bryce, 2003). A recent study (Jones et al., 2003) estimates that more under-5 deaths from any cause could be prevented through the appropriate use of oral rehydration therapy than through any other preventive or treatment interventions. Frequent episodes of diarrhea are associated with undernutrition, poor growth, decreased immune response and death (Lanata and Black, 2001). Clinical trials in Peru, Romania and Europe (Brown et al., 1988; Nanulescu et al., 1995; Sandhu et al., 1997) indicate the importance of giving children suffering from acute diarrhea full-strength diets shortly after illness onset. Bilateral and multi-lateral

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[1] For example: " ?Cuando un niño tiene diarrea, se le debe dar menor cantidad de LIQUIDOS, igual cantidad, o mayor cantidad de lo usual?" Bolivia DHS (1994), p. 234.

organizations, including the US Agency for International Development and the World Health Organization recommends offering increased fluids and food to sick children, including those experiencing diarrhea (BASICS, 2001; WHO, 2001)[2]. Based on DHS estimates, the average Bolivian child will face almost 24 episodes of diarrhea in the first three years of his or her life.[3] The average Malagasy child will face more than 20 episodes of diarrhea in the same time period.

Table 1: Frequency of reported diarrhea in the last two weeks, by age of child				
	less than 1	age 1	age 2	average 0-3
Bolivia	25.4%	41.2%	24.6%	30.4%
Madagascar	22.1%	32.0%	24.3%	26.2%

The question is also an excellent candidate for studying knowledge diffusion because a factually correct answer exists and is and uniform across individuals. Due to the high risk of dehydration, giving less fluid is an unambiguously wrong answer (UNICEF 2003). The medically accepted practice is that it is always good to raise fluid intake during episodes of diarrhea since doing so reduces the risk of dehydration with its severe and potentially fatal consequences. The question on fluid intake during episodes of diarrhea is in contrast to some studies which examine opinions, attitudes or preferences about which there is no objectively "correct" answer or questions about which there is a great deal of heterogeneity. When examining preferences or behaviors, it is difficult to

[2] While currently we only examine fluids we plan to extend to food practices as well.
[3] If a child has a 30 percent chance of diarrhea in any two week period, then the expected incidence in three years would be would be .3*26*3=23.6.

distinguish between social learning and other social influences. Women who have considerable social contact with mothers who have few children may be more likely to express a preference for, and have, fewer children. It is possible that these women have "learned" from the experience of their peers. But it is also possible that having few children is attributable to their desires to conform to the opinions and behaviors of a "reference group." With respect to farming practices, even within geographically limited areas there is a great deal of local heterogeneity—in soil conditions, in reliability of access to irrigation, in access to labor—such that what is optimal for one farmer may not be optimal for his or her neighbor.

The question about fluid intake has a uniform and factually correct response; however, the answer is not "obvious" nor can the answer be immediately inferred from direct experience. Howard Gardner's theory of the "unschooled mind" (1991) argues that children operate with "intuitive" models which are based on "common sense" and experience[4]. There is also an "intuitive" biology on which common sense health practices are based. It is not obvious how to respond to an episode of diarrhea. One "intuitive" model might be to increase fluid intake to replace the excess of fluids being lost. Another plausible model suggests that if fluid output is excessive, then limiting fluid intake might help the child.

Additionally, the advantage of giving as much or more liquids is not immediately apparent. Parents and other caregivers may not be able to discern the often subtle changes that occur in children's health nor ascribe such changes to giving more liquids. As Das and Sanchez-Paramo (2003) indicate nearly all cases of diarrhea are "self-limiting;"

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[4] For instance, Gardner (1991) argues that most people operate with an Aristotelian, not Newtonian, intuitive physics as their experience is that objects do *not* tend to remain in motion but rather slow down and stop without continued impetus.

hence, the difference in outcomes between correctly giving increased fluids and incorrectly failing to give more fluids is probably quite close.[5] It would be difficult for a single woman to infer from direct observation of her own children, or even from observing other cases that the correct treatment is “more fluids”. These two arguments imply that knowledge of the correct response is likely to be “learned” from some source and not simply “intuited” or “inferred” from experience. Table 2 shows that there are a considerable number of women who give the wrong answer: 16% of women in both Bolivia and Madagascar say “less fluid” should be given during episodes of diarrhea.

Table 2: Responses to hypothetical and actual behavior, in percents

	Bolivia		Madagascar	
Fraction responding to hypothetical	Fraction	Of which those whose reported behavior matched	Fraction	Of which those whose reported behavior matched
Give less	16.0	69.3	16.6	72.3
Same	19.0	57.0	10.0	49.2
Give More	63.3	72.7	72.2	82.0

Source: Analyses of DHS

The hypothetical question about liquid intake during diarrhea is informative because there is a cross check on reported knowledge: actual behavior. Before women are asked the hypothetical question about liquids they are questioned about whether their child had an episode of diarrhea in the previous two weeks. If their child had an episode,

[5] Parents’ perceptions of treatment outcomes may be close to equal; however, since parents want to know the correct treatment and because the potential adverse outcome is severe (potential death), the gain in knowing information that would produce even small differences is large.

mothers are asked a series of questions about that episode, including questions about fluid intake. There is a strong association between the hypothetical answer and the behavior. Of Bolivian mothers that reported "more fluids" in the hypothetical question 73% gave more fluids, 16% gave the same amount, and only 10% gave less fluid. Of mothers who reported a hypothetical answer of "less fluids", 69% actually gave less fluid. Madagascar's numbers are similar (Table 2).

Finally, this question is of interest because information about appropriate fluid intake is valuable to each caregiver; consequently, there is no reason not to share it, since benefits from this knowledge are not zero sum. In many instances, information conveys an advantage, which would reduce incentives to share. However, in this case, the better health of another woman's child imposes no costs to the knowledgeable caregiver and may, in fact, increase his or her prestige.

III. Empirical determinants of knowledge of correct treatment

Demographic and Health Surveys (DHS) have been conducted in over 60 countries in three rounds between 1984 and 2001. Data is collected on maternal and child health, nutrition, fertility and family planning at household and individual levels. In all results presented here, the sample is nationally representative of women aged 15-49 living in urban and rural areas.

In Bolivia households were selected using census tracks. In this paper, we use unweighted data on wives and female heads of household giving us a sample of over 4,800 women in more than 600 geographic clusters in Bolivia in 1994, and over 3,300 women in over 260 clusters in Madagascar in 1997

With respect to limitations of the survey, there are two problems with question placement. First, before they are asked the knowledge question, the subset of mothers who have had a sick child within the previous two weeks will have heard questions on practice (for each ill child), including: Did you give your ill child more/same/less fluids and foods?, Did you give ORS to the ill child?, What else did you give?, and Who did you ask for treatment help? However, it seems unlikely that these questions will have created a systematic bias among mothers with sick children regarding our theoretical treatment question.

For these analyses, we consider "more" and "same" to be correct answers. In probit regressions, we include individual variables, the fraction of the sampling cluster which answered the question correctly, and the cluster averages of all of the variables included at the individual level.

III.A) Individual and households determinants of knowledge

Before moving to the question of social learning, we must first address other ways in which women may have learned the appropriate treatment, including education, literacy, and exposure to the media. Additionally, one could conjecture that women who have more children or who are older will have had, all else equal, more opportunities to learn. In Bolivia and Madagascar, nearly all of these factors are associated with the probability of a correct response regarding fluid intake during diarrhea and are statistically significant.

Maternal education, literacy, age, and media exposure. Maternal education has a large impact on child health and mortality, both in aggregate and individual data. The underlying mediating mechanisms—lower rates of disease, better treatment when sick,

and greater autonomy in decision-making have been debated (Caldwell 1979, Cleland and van Ginneken 1988). In particular it is not clear whether education has a direct effect because of what is learned in school or whether the acquisition of learning skills allows women to accumulate knowledge. Glewwe (1997) using data from Morocco finds that the impact of schooling on mothers' health behaviors appeared to be the result of direct knowledge learned in school as part of the curriculum, not general knowledge nor the ability to acquire knowledge. In our results we find a little of both. Education (mother's years of formal schooling completed) has a direct effect, but literacy also has distinct effects so that, even for a given level of education, women who report greater ability to read are more likely to know the right answer.

There is a minor effect of the total number of children ever born, but the impact insignificant. Age also plays some role (suppressed in the reporting of the results).

Media exposure. Media exposure also has a large impact on knowing the correct answer regarding liquid intake during diarrheal episodes. It is not clear whether this represents a truly causal impact of media (i.e., women learn directly from the media) or whether this variable is capturing some other aspect of women's lives. Certainly media exposure at the individual level is an endogenous choice variable so it is not clear exactly what this represents. Results from a recent study on the impact of social marketing on women's knowledge and use of multivitamins in Santa Cruz, Bolivia indicates that women learn directly from the media (Warnick, in press).

Table 3: Probit regressions including cluster less household fraction correct, individual and household variables, and cluster averages of all variables						
	Bolivia			Madagascar		
	All	Urban	Rural	All	Urban	Rural
Fraction Correct in Cluster	0.116* (0.030)	0.009 (0.041)	0.218* (0.057)	0.285* (0.039)	0.121* (0.040)	0.385* (0.056)
Individual and household variables						
Education (Years of Schooling)	0.008* (0.002)	0.004* (0.002)	0.020* (0.006)	0.011* (0.002)	0.004* (0.002)	0.016* (0.004)
Reads Easily	0.048* (0.020)	0.037 (0.022)	0.043 (0.042)	0.028 (0.018)	-0.009 (0.011)	0.043 (0.026)
Reads with Difficulty	0.013 (0.013)	0.006 (0.015)	0.006 (0.029)	0.029* (0.012)	-0.020 (0.026)	0.050* (0.017)
Exposure to Media Index	0.321* (0.100)	0.321* (0.087)	0.126 (0.243)	0.145 (0.098)	0.072 (0.084)	0.162 (0.151)
Total Children Ever Born	0.002 (0.002)	0.003 (0.002)	0.006 (0.004)	0.005* (0.002)	0.009* (0.002)	0.003 (0.003)
Education of Husband	0.001 (0.001)	0.001 (0.001)	0.002 (0.002)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Wealth Index	0.011* (0.005)	0.004 (0.005)	0.031* (0.014)	-0.008 (0.005)	-0.005* (0.002)	0.007 (0.011)
Urban Residence	0.017 (0.017)			0.009 (0.014)		
Statistically Significant Varriables not reported	Age, Age^2		Age, Age^2, c_media	c_media		c_media
N	4805	2996	1809	3381	1120	2261
Cluster averages included?	Yes	Yes	Yes	Yes	Yes	Yes
Psuedo R2	0.1126	0.1001	0.0575	0.1488	0.2322	0.1086

Coefficients are marginal effects (not probit coefficients). Standard errors are in parenthesis. Suppressed variables include cluster averages (denoted for example c_media), Age, and Age^2.
* coefficients are statistically different from zero at the 5% significance level

Household characteristics. Measured wealth of the household (using a principal components index of asset ownership and characteristics of the house as in Filmer and Pritchett 2000) has a modest effect on correct knowledge in Bolivia—but only in rural areas. Mothers residing in urban areas are more likely than rural residents to be

informed—but the effect is not significant.   Interestingly, the husband's education plays no role at all.

III.B) The role of neighbor's knowledge

The first cut in examining social learning is to examine whether or not women who live in clusters in which other women are more likely to know the correct response are also themselves more likely to know the right answer, adjusting for individual and household variables. Of course, this is not direct evidence of social learning, but it is consistent with social learning.

If we include the average fraction correct in each cluster (excluding the woman reporting) we get absolutely large (.116 in Bolivia, .285 in Madagascar) and statistically significant estimated association. In Madagascar, if the fraction of other women living in the cluster who answer correctly is higher by one standard deviation (15.5 percentage points), then the likelihood that a woman living in that cluster also answers correctly (controlling for all of her characteristics) is 4.42 percentage points higher. This is a substantial effect—roughly equivalent to the impact of four additional years of schooling (..011*4=.044) (keeping in mind this is the partial effect of schooling not including its impact via improved literacy). A 10% increase in the cluster (less respondent) fraction correct increases the likelihood of a correct answer by about the equivalent of improving the woman's literacy from "cannot read" to "reads with difficulty"—2.85. percentage points vs. 2.8 percentage points.

We cannot prove that these effects are the result of social contacts and social learning as we lack an adequate identification strategy (for some ideas, see below). But there are aspects of the data that suggest the effect might be a social learning effect.

First, it is possible that there are cluster-specific characteristics, e.g. women are more likely to be informed in wealthier clusters or clusters with high education (independent of the fraction which responds correctly). However, if we include the cluster averages of all variables and the fraction right, none of the cluster variables has any explanatory power and the fraction right continues to come through strongly[6].

Second, it is a plausible conjecture that a sampling cluster in a rural area is more likely to include people who interact socially that in an urban area in which social interactions are plausibly less determined by proximity (although if a rural area is sufficiently sparsely populated, interactions could be limited so that while all interactions are with neighbors there are few interactions with neighbors). If the social learning effect is mediated by direct social contacts, then the effect should be lower in urban areas than in rural areas. This is strikingly true in the estimates for both countries. In Bolivia, the cluster effect of fraction correct in the urban sample is only .009 and not significant while the cluster effect in rural areas is .218—24 times larger than the urban effect and statistically significant. Media exposure has a much larger impact in urban as opposed to rural areas (.321 vs. .126), and is only significant in urban areas. In Madagascar the rural effect (.385) is three times larger than the urban effect (.121). This does not imply that social learning is smaller or less important in urban areas; however, living in close proximity is likely to be a much poorer proxy for the likelihood of social contact. This is consistent with a social learning explanation.

[6] The regression with cluster effects suggests a large amount of variation associated with clusters. For example, in Bolivia, the R2 increases from .08 to .22 . This means adding 615 variables so one would expect a fair degree of explanatory power. The adjusted R2 increases to only to .105. We obtain similar results in Madagascar.

If what we see can be explained by social learning, then it should be interactive—that is, greater social contacts with individuals who are informed should be informative. As it is, we do not have any direct information on social contacts from DHS surveys. One approach around this issue is to use variables that we conjecture are related to the likelihood of social contact—for example, age and ethnicity, and examine whether the impact of other women is interactive.

We feel that the most plausible alternative to social learning to explain our results is that something actually happened in the cluster that affected women's knowledge. Suppose that in one cluster the rural health post or clinic is particularly effective at outreach. Then there will be a correlation among women across villages (clusters) due to that fact even in the absence of social learning. We are also working on how to distinguish that effect from the social learning effect.

Conclusion and planned extensions

The beauty of working with the DHS is that, once one has a particular estimate it is easy to replicate that same set of estimates across a substantial number of countries. This allows an important robustness check on results (and avoids "publication bias" and suggests generalizability). We plan to create a relatively large number of country estimates of the type we have reported here for Bolivia and Madagascar as an indicator of the diffusion of information across various countries, as well as regions within countries. The main problem of course is the usual problem of identification, in the sense of distinguishing social learning from other possible explanations of the existing cluster effects.

References

Basic Support for Institutionalizing Child Survival (The BASICS Project). *Emphasis behaviors in maternal and child health report*. Author, Arlington, VA, 2001.

Belasco DR. Adoption of community water systems: an area study in three villages in Muhafzat Kofr-Shayky, Egypt. Thesis, University of Denver, 1989.

Berelson B, Freedman R. A study in fertility control. *Scientific American*. 1964;210:29-37.

Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? *Lancet*. 2003;361:2226-2234.

Brown KH, Gastaaduy AS, Saavedra JM, Lembcke J, Rivas D, Robertson AD, et al. Effect of continued oral feeding on clinical and nutritional outcomes of acute diarrhea in children. *J Pediatr*. 1988;112:191-200.

Caldwell J.

Casterline and ….

Castle SE. Empowering children as health educators: an evaluation of the impact of Save the Children's village schools program on maternal and child health in Kolondieba, Mali. Westport, CT, Save the Children, 1997.

Cleland, J.G. and J.K. Van Ginnekin, 1988, "Maternal Education and Child Survival in Developing Countries: The Search for Pathways of Influence," *Social Science and Medicine, 27(12): 1357-1368.*

Curtis V, Cousens S, Mertens T, Traore E, Kanki B, Diallo I. Structured observation of hygiene behaviours in Burkina Faso: validity, variability, and utility. *Bulletin of the World Health Organization*. 1993;71:23-32.

Das and Sanchez-Paramo,

Dearden K, Altaye M, de Maza I, de Oliva M, Stone-Jimenez M, Burkhalter BR, Morrow AL. Evaluation of the impact of mother-to-mother support on optimal breastfeeding: A controlled community intervention trial in peri-urban Guatemala. Pan American Journal of Public Health. 2002;12, 3, 193-201.

DHS 1994 Bolivia Final Report.
http://www.measuredhs.com/pubs/pdftoc.cfm?ID=99 , 9/16/03

DHS 1997 Madagascar Final Report.

http://www.measuredhs.com/pubs/pdftoc.cfm?ID=135, 9/16/03

Gardner, Howard, 1999, The Uncshooled Mind. Basic Books.

Glewwe, Paul. 1999. "Why Does Mother's Schooling Raise Child Health in Developing Countries? Evidence from Morocco." Journal of Human Resources 34(1):124-159

Goldman N, Pebley AR, Beckett M. Diffusion of ideas about personal hygiene and contamination in poor countries: evidence form Guatemala. *Social Science and Medicine*. 2001;52:53-69.

Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS, the Bellagio Child Survival Study Group. How many child deaths can we prevent this year? *Lancet*. 2003;362:65-71.

Lanata CF, Black RE. Diarrheal diseases. In: Semba RD and Bloem MW, eds., *Nutrition and health in developing countries*. Humana Press, Totowa, NJ, 2001.

Middlestadt SE, Bhattacharyya K, Rosenbaum J, Fishbein M, Shepherd M. The use of theory based semi-structured elicitation questionnaires: formative research for CDC's prevention marketing initiative. *Public Health Reports*. 1996;111:18-27.

MkNelly B, Dunford C. Impact of credit with education on mothers and their young children's nutrition: lower Pra rural bank credit with education program in Ghana (Research Paper #4). Davis, CA, Freedom from Hunger 1998.

Montgomery MR, Casterline JB. The diffusion of fertility control in Taiwan: evidence from pooled cross-section time-series models. *Popul Stud (Camb)*. 1993;47:457-479.

Nanulescu M, Condor M, Popa M, Muresan M, Panta P, Ionac S, et al. Early re-feeding in the management of acute diarrhea in infants of 0-1 year of age. *Acta Paediatr*. 1995;84:1002-1006.

Pinfold JK. Analysis of different communication channels for promoting hygiene behavior. *Health Education Research*. 1999:14:629-639.

Sandhu BK, Isolauri E, Walker-Smith JA, Banchini G, van Caillie-Bertrand M, Dias JA, et al. Early feeding in childhood gastroenteritis. *J Pediatr Gastroenterol Nutr*. 1997;24:522-527.

Rogers EM. *Diffusion of innovations*. New York, The Free Press, 1995.

Rogers EM, Kincaid DL. Communication networks: toward a new paradigm for research. Free Press, New York, 1981.

Rutenberg N, Watkins SC. The buzz outside the clinics: conversations and contraception in Nyanza Province, Kenya. *Studies in Family Planning*. 1997;28:290-307.

Ryan B, Gross NC. The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology*. 1943;8:15-24.

Stanton BF, Clemens JD. An educational intervention for altering water-sanitation behaviours to reduce childhood diarrhea in urban Bangladesh, II. A randomized trial to assess the impact of the intervention on hygienic behaviors and rates of diarrhea. *American Journal of Epidemiology*. 1987;125:292-301.

UNICEF. 'Facts for life: Diarrhoea'. New York. http://www.unicef.org/ffl/07/1.htm.

Valente TW (1995). Network models of the diffusion of innovations. Cresskill, NJ: Hampton Press, Inc.

Warnick E, Dearden KA, Slater S, Butrón B, Lanata CF, Huffman SL. Social marketing in Bolivia improved use of multiple vitamin/mineral supplements among resource-poor women. Manuscript under review.

Watts DJ. *Small worlds: the dynamics of networks between order and randomness*. Princeton University Press, Princeton, NJ, 1999.

Wellin E. Water boiling in a Peruvian town. In Paul BD, ed. Health, culture, and community: case studies of public reactions to health programs. New York: Russell Sage Foundation, 1955.

World Health Organization. Improving family and community practices: a component of the IMCI strategy. Author (WHO/CHD/98.18), Geneva, 2001.

TABLE 2a: Comparison of the responses to the hypothetical question about whether to provide more or less fluids during an episode of diarrhea and reported practice among mothers with children experiencing diarrhea, Bolivia						
		In Practice				
Response to hypothetical		**Decreased fluids**	**Gave same amount**	**Increased fluids**	**Don't Know**	**Total**
	Give less	79	17	17	1	114
		69.3	14.91	14.91	0.88	100
		53.74	10	4.44	8.33	**16.01**
	Give same	17	77	37	4	135
		12.59	**57.04**	27.41	2.96	100
		11.56	45.29	9.66	33.33	**18.96**
	Give more fluids	45	72	328	6	451
		9.98	15.96	**72.73**	1.33	100
		30.41	42.35	85.64	50	**63.34**
	DK	6	4	1	1	12
		50	33.33	8.33	8.33	100
		4.08	2.35	0.26	8.33	1.69
	Total	147	170	383	12	712
		20.65	**23.88**	**53.79**	1.69	100
		100	100	100	100	100
Source: based on questions XXX and XXX. JEFF						

TABLE 2b: Comparison of the responses to the hypothetical question about whether to provide more or less fluids during an episode of diarrhea and reported practice among mothers with children experiencing diarrhea, Madagascar						
		In Practice				
Response to hypothetical	x	**Decreased fluids**	**Gave same amount**	**Increased fluids**	**Don't Know**	**Total**
	Give less	73	7	18	3	101
		72.3%	6.9%	17.8%	3.0%	100.0%
		58.9%	8.9%	4.5%	30.0%	**16.6%**
	Give same	12	30	17	2	61
		19.7%	**49.2%**	27.9%	3.3%	100.0%
		9.7%	**38.0%**	4.3%	20.0%	**10.0%**
	Give more fluids	36	41	361	2	440
		8.2%	9.3%	**82.0%**	0.5%	100.0%
		29.0%	51.9%	**91.2%**	20.0%	**72.2%**
	DK	3	1	0	3	7
		42.9%	14.3%	0.0%	42.9%	100.0%
		2.4%	1.3%	0.0%	30.0%	**1.1%**
	Total	124	79	396	10	609
		20.4%	**13.0%**	**65.0%**	**1.6%**	100.0%
		100.0%	100.0%	100.0%	100.0%	100.0%
Source: based on questions XXX and XXX. JEFF						