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Social learning about levels of perinatal and infant mortality in Niakhar, Senegal

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Introduction

The idea that perceptions of declining infant and child mortality and (or) increased survivorship resulting from the early stages of mortality transitions (from high mortality to low) that have taken place around the world influenced individuals to have fewer children holds a central though uncorroborated place in most theories of the demographic transition (from high fertility and high mortality to low fertility and low mortality). Although early work attempted to measure perceptions of infant mortality as an explanation for fertility and family building behaviour, little research has investigated how such perceptions are formed and updated. Perhaps because of the difficulty of measuring perceptions – and those early efforts' lack of success – still another line of research attempted to bypass subjective perceptions altogether in analyses of how contextual levels of mortality measured at the aggregate level were associated directly with fertility behaviours.

That perceptions of infant and child mortality levels and change have largely been bypassed by the demographic community is unfortunate. How individuals develop these perceptions is relevant not only to demographic transition theory but also to a much broader question in the social sciences: how subjective perceptions of constraints and opportunities for action learned from the environment shape – and perhaps motivate – human behavior. Learned subjectivity in this sense is central to a wide body of modern social theory, but empirical identification, as in the case of mortality perceptions, has remained elusive.

From a cognitive perspective, the problem of how population level contextual information about major trends such as the force of mortality are integrated into subjective perceptions has long puzzled analysts. Human cognition seems plagued with mechanisms that hinder the rapid assimilation of trends in aggregate phenomena. An important line of theory in artificial

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intelligence and cognitive psychology suggests that it may be best to turn the problem around, identifying the learning mechanism by which such perceptions are formed as working through differential exposure to information and experience. For infant mortality, a principal mechanism for such differential exposure is to be found in heterogeneous patterns of social interaction.

In this paper, we model perceptions of mortality change as a function of this type of heterogeneous information concerning perinatal and infant mortality in individuals' social networks. We contrast the association between perceptions of mortality and this type of information to that derived from aggregate measures of mortality experience of the type commonly used in multilevel models of fertility behaviour to proxy individual level informational contexts under the assumption that everyone within a given area is exposed to the same information.

Within networks, contacts may differ in influence. Accordingly, we explore whether information concerning the mortality experiences of network members who are particularly close to respondents have a stronger association with perceptions of infant mortality levels than information concerning the experiences of those who are less close, representing 'weaker' ties. Another source of difference may be the sequencing of exposure to particular mortality experiences. We test whether more recent experiences of infant mortality among network members have a stronger association with perceptions of mortality levels than earlier ones.

To adequately address the hypotheses forwarded here concerning these interactional mechanisms, we control for structural (non-interactional) factors that may be associated both with individuals' perceptions of mortality change and the mortality experience of their network members. These include respondents' own experiences with child mortality, residence in a rural setting versus in a town, level of education, and perceptions of the desirability of seeking modern health care during childbirth.

Social learning about infant and child mortality

Social learning about infant and child mortality has a relatively special place in the demographic literature. In large part, this owes to the central role mortality has been theorized to play in the onset of fertility transitions, with lower infant and child mortality hypothesized to lead after a lag period to lower fertility (Notestein 1945; Chesnais 1992; Mason 1997; Freedman 1979; Lloyd & Ivanov 1988). Though aggregate associations between infant and child mortality and fertility over the years have tended to support this general relationship, they have been received skeptically due to the possibility of spurious causation. Specifically, the fear is that they may be associated with other factors in socio-economic development or be due to the well known reverse causal path from higher, faster fertility to higher mortality (Hobcraft 1992; LeGrand & Phillips 1996).

These problems, in conjunction with a conviction that individuals should make decisions about having children based on the experience of child mortality of those around them, led many to search for individual level volitional mechanisms linking infant and child mortality and fertility. The majority of work in this area focused on the themes of 'replacement' (where the loss of a child influences the family's / individual's fertility) and 'insurance' (where expectations concerning potential future mortality influences fertility) effects (Cohen & Montgomery 1998; Preston 1978). Almost no research, however, has been able to identify consistent insurance effects, which in principle would have the largest impact on fertility change. This is in part because such effects are fundamentally related to *perceptions* of levels of mortality and associated risk (Montgomery 1998; J. Sandberg 2006; LeGrand & J. Sandberg 2006).

Early research concerning perceptions of child mortality generally employed indirect, stylized survey measures. In a review of this work, survey measures of fear of child death and perceptions of increased child survival were seen at times to be associated with number of births, ideal numbers of children, and contraceptive acceptance and use (Taylor et al. 1976). The record in this regard, however, is mixed; perceptions of child survival measured in this way did not always have the expected effects (Heer & Wu 1978). One of the potential reasons for the inconsistent results seen may stem from systematic measurement error in these types of instruments. There is no reason to assume, for example, that respondents can adequately conceptualize mortality experience as a rate in the way demographers and other social scientists do, or that response categories in stylized survey measures are equivalent across respondents (Sandberg 2006).

To avoid the problems associated with measuring perceptions, later research would attempt to model *contextual* mortality directly, using aggregate measures of mortality as independent variables in models of fertility and family building processes. Such aggregate contextual measures are assumed to broadly proxy individuals' informational environments with a relatively objective metric for individuals' mortality contexts. This line of research, however, was even less successful in identifying linkages between mortality and family building behaviours than that employing conventional survey measures of perception. The principal problem with this approach is that it rests on the assumption that all individuals in a given area are exposed to the same fixed distribution of information with regards to infant and child mortality. This assumption of homogenous mixing is problematic because even small differences in contextually available information due to differential patterns of association may lead to differing perceptions on the individual level within the same broad aggregate of a population. A small body of later research, which the present research builds upon, would attempt to redress this with significantly more success by linking heterogeneous interpersonal contextual levels of infant mortality – as measured through kin and social networks – to family building (Pebley et al. 1979; Sandberg 2005; Sandberg 2006).

Heterogeneous association and perception

The disjuncture between these two lines of inquiry – one concerning the potential influence of subjective perceptions, the other objective experience of infant and child mortality on family building behaviours – underscores the dearth of research concerning the intermediate link between the contextual experience of mortality and its subjective perception. It is in understanding the mechanisms linking individual experience and subjective perception of constraints and opportunities for action, however, that the greatest potential exists for expanding empirical understanding of how mortality perceptions influence behaviours concerning family building. More importantly, such research holds the potential to reveal mechanisms through which social-environmental contexts influence subjective perceptions and actions potentially contingent on them more generally.

Learning about mortality is a special case of this general problem of integrating experience, both personal and interpersonal, into subjective perception. This subject has unique advantages relative to learning about many other phenomena. First, losing an infant is generally not volitional. Parents can be assumed to do the best they can, given their resources, to keep their children alive. Second, at the time it happens it is public knowledge (Sandberg 2006). Anyone interacting in one way or another with a parent will have access to accurate information about its occurrence and to some degree the circumstances surrounding it, such as the child's age. Because family is such a central and public component of life in most populations, and perhaps because infant death is so affectively salient, it is also probable in many cases that individuals will have relatively good knowledge of infant deaths that occurred prior to their acquaintance with another, compared to, for example, knowledge of other demographic phenomena such as use of contraception. This second observation suggests that such knowledge of prior events may be more complete the closer that egos and alters are, affectively.

About 10 years ago Montgomery described a number of cognitive mechanisms that put individual perceptions of mortality decline at odds with putatively objective, population level evidence of such declines (1998; 2000). These included cognitive mechanisms related to the visibility of events versus non-events, the sequencing of events (where earlier or more recent information may influence perceptions disproportionately), neglect of base rates, and a (seeming) over-reliance on sample evidence. With regard to this latter effect, evidence has long suggested that individuals seem to place emphasis on central tendencies drawn from such sample evidence with little regard to its predictive power (Tversky & Kahneman 1974). What these effects point to, in general, is a set of cognitive mechanisms well adapted to integrating information from relatively small samples of individual experience, conditional on its sequencing. Individuals may, for example, place more emphasis on sample experience over base rates because base rates are generally not available to them. They may place more emphasis on central tendencies either because in small samples trying to assess predictive validity is futile, or because they perceive their experiences not as a sample but as a population (being all they know, c.f. Montgomery 2000), or both.[1] Instead of looking at mortality perceptions as a function of cognitive mechanisms producing systematic deviations from objective reality, it may be more appropriate to look for a model of such perceptions based in individuals' sample experience, as it were: specifically, in their own experience and that of those they interact with.

Cognitive psychologists, anthropologists and, increasingly, sociologists use just such a model of subjective perception and, more broadly, the cognitive frameworks they are a part of, through which individuals experience, interpret, and gather information in their environments. Known as schemas, these interpretive frameworks for different situations, behaviors, and events are related to others in nested, hierarchical causal structures (D'Andrade 1995) as well as through non-hierarchical associations stemming from the multiplexity of contextual stimuli. Schemas learned through experience and interaction have long been identified (though not by that name) as the motivating force for action across a wide body of sociological and economic thinking, from methodological individualism (Weber 1978; Hayek 1980) to practice theory (Bourdieu 1977; Giddens 1984), symbolic interactionism (Goffman 1986), and phenomenology (Berger & Luckmann 1966).

The mechanisms through which these schemas – or perceptual frameworks – develop, however, has been largely neglected. This gap has begun to be filled in by scholars in cognitive psychology, artificial intelligence, and cognitive anthropology. The 'connectionist' or 'parallel distributive processing' (PDP) model suggests that schemas can be thought of as representations of general contexts with associated possibilities for and constraints on action drawn from the weighted aggregation of repeated imprints of different, particular experiences (Smith and Queller 2004; Strauss and Quinn 1998). A connectionist model of cognition provides a solution to the problem of linking change in aggregate level phenomena with individual perceptions of it. From this perspective, schemas – or representations of the world motivating action (such as that concerning the survival of children) – are indeed shaped by the population context in which individuals find themselves but *stochastically*, as

[1]It may not be surprising that individuals ignore base rates, even when they are made available to them. Quantitatively oriented social scientists are cautioned early in their training against drawing ecological inferences about the condition of individuals from aggregate summary statistics. It is possible that an individual's idiosyncratic experience of the world may in some cases provide greater predictive power than base rates from larger population aggregates because of the close intersection between their environmental context and that of others with whom they interact.

a function of particular experiences. Such a model of subjectivity provides a direct counterpoint to models of homogeneous mixing in which mortality perceptions are assumed to be derived from the same fixed information by all members of a particular population (Montgomery 2000).

The social network turn in demography

Social network research in demography has been moving toward just such a connectionist position. Motivated at the outset by models of diffusion of information and their potential influence on demographic and health behavior, research on social networks has been intense during the last decade. Social learning through heterogeneous interpersonal channels is thought to play a major role in a myriad of demographic phenomena, including the acceptance and use of contraceptives and fertility limitation (Behrman et al. 2002; Kohler 1997; Kohler et al. 2001; Montgomery & Chung 1999), control over and pace of family building (Sandberg 2006; Sandberg 2005), migration decisions (Deléchat 2001; Massey 1990; Palloni et al. 2001), and perceptions of the risk of infection from AIDS and associated preventative measures (Behrman et al. 2003; Buhler & Kohler 2002; Helleringer & Kohler 2005). Recent research in the field of public health has also highlighted potential influences associated with a wide range of health outcomes and behaviors (Smith and Christakis 2008).

Setting

To study the impact of heterogeneous experience of contextual mortality on perceptions of infant mortality and its change we use data collected in collaboration with the *Institut de recherche pour le développement* (IRD), Senegal, at the Niahkar Demographic and Health Surveillance site in the *Siin* region of Senegal. Founded in 1962, the Niakhar Demographic Surveillance System (NDSS) is one of the premier sources of longitudinal demographic monitoring information in the world. The current study area covers a population of approximately 30,000 individuals in 30 villages which have been under demographic surveillance for 27 continuous years. The NDSS gathers complete household listings of critical demographic and bio-medical events and processes, including fertility and mortality, and has updated them at least quarterly since 1983.[2]

Population growth; fertility and mortality

Approximately 150 km. due east of Dakar, the population of the study area is ethnically Sereer and predominantly Muslim. The vast majority of the population is engaged in agricultural production of millet, a consumption staple, and peanuts, which are grown for sale in the cash economy. Households (or hearths) based on nuclear families are the primary unit of production and consumption, organized into kin-based enclosed residential compounds (Sereer: *Mbind*). Compounds can contain anywhere from one to over a dozen households. The average per compound is 1.6 households and 17 individuals (Delaunay et al. 2002).

The population of the study zone is experiencing a rapid natural increase. On the fertility side, a TFR of approximately seven was recorded in 2005. This high fertility is not unusual for rural Senegal, where the diffusion of contraception has been weak and temporary labor migration allows large families to diversify family production (Adjamagbo et al. 2006; Valérie Delaunay et al. 2008). Perhaps most importantly the population saw a sustained decline in infant and child mortality in the four decades prior to the collection of data for the

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[2]The Niakhar surveillance system has had four distinct phases since 1962, corresponding to enlargements and reductions of the geographic area and population under surveillance (Delaunay et al. 2002). For the purposes of this research, we focus on the most recent period, beginning in 1983.

present study. Infant mortality in the study area declined from 223/1000 in the period 1963–1967 to 80/1000 in the period 1994–1999 (Delaunay et al. 2001) and 31/1000 in 2007, the year the network data used here were collected (Trape et al. 2010). Neonatal mortality, or death in the first 29 days to live births, a major component of the overall infant mortality trend, declined from 40/1000 in 1989–1991 to 24/1000 in 1998–2000 (Etard et al. 2004). Under-five mortality also decreased dramatically, from approximately 485/1000 in 1963–1967 to 213/1000 in 1994–1999 (Delaunay et al. 2001) and to 76/1000 in 2007 (Trape et al., 2010). In total, these represent decreases of 86% and 84% over the period in infant and under-five mortality, respectively.

This secular decline in infant and child mortality provides a clear baseline from which to assess perception of change in mortality levels among members of the study population. If the assumption of homogenous mixing (that all individuals in the study area are exposed to the same aggregate experience of infant and child mortality) holds and, further, individuals' perceptions of this change objectively reflect this trend, then we would expect that perceptions of the mortality decline would be universal. As will be shown, this is not the case. The alternative hypothesis from the discussion above is that individuals' perceptions of whether mortality has declined depend on their heterogeneous exposure to infant and child mortality through their social ties.

Hypotheses

Drawing from the discussion concerning learning and the development of perceptions through heterogeneous interactional experience, the first hypothesis to be tested here is that respondents' network experience with perinatal and infant mortality will be associated with the likelihood of perceiving an increase in, or unchanging level of, infant mortality relative to the past. Though, in general, assessing associations between measured levels and perceived change can be problematic, it is appropriate here. The secular decline in infant mortality in the study area means that, relative to any period in the past, there is a 'correct' answer to the question of change in the level infant mortality: it has decreased. If individuals in the study area have any scientifically derived knowledge of the mortality trend (which is unlikely), or if the experience of their network alter mirrors trends in this population, we would expect them to perceive, correctly, an overall decline in infant mortality. In contrast, individuals' stated perception of the lack of change or an increase in infant mortality may be influenced by relatively high levels of mortality in their interpersonal experience at the time of the survey, or through time. Since this is our proposed alternative to the homogeneous mixing model discussed above, an ancillary hypothesis to this is that the experience of social network alters will capture a large part of any effect identified by broader measures of contextual mortality taken at the village or compound level.

The second hypothesis to be tested here is that perinatal and infant mortality experiences of more socially proximate alters will be more salient, potentially better known, and therefore carry more weight than those of less proximate alters in their influence on perceptions of mortality change. There are a number of reasons to expect this. The experiences of more proximate alters may be more salient due to higher levels of interaction, because the affective impact of their mortality experiences is stronger than that of less proximate alters, or both. There is, however, theoretical reason to expect just the opposite effect, with the experiences of less proximate alters (representing weak ties) carrying more weight in the formation and updating of mortality perceptions. This may be the case especially where the experience of more proximate alters, representing stronger network ties, is relatively homogeneous and that of less proximate alters introduces information at variance with that gained from stronger ties (Granovetter 1973).

Derived from Montgomery's discussion of sequencing effects in relation to mortality perceptions, the third and final hypothesis to be tested here concerns the effect of the recency of mortality experience within networks. Simply put, if more recent experience of infant loss among network alters is more readily available to respondents when assessing the likelihood of infant mortality we would expect these experiences to be more strongly associated with mortality perceptions than those further in the past.

Data

The Niakhar social networks pilot survey

In 2007, the Niakhar Social Networks Pilot Survey (NSNPS) was fielded in six villages in the NDSS study zone. Sampling for the main survey instrument followed a two-stage design. First, two villages within each of three distinct regions within the zone were selected. Within each of these, 40 individuals between the ages of 18 and 65 were chosen at random from residents in the surveillance system database for interviewing. Due to the liberal definition of residence in the NDSS, this sample included a large number of people who, though previously resident, visit the zone only once or twice a year. Of those who were ascertained to be full-time residents, there were seven refusals of the survey instrument. In total, interviews were completed with 141 respondents and partially completed with 6 others yielding a response rate of 91% for full-time residents (Rytina et al. 2008).

Designed to overcome shortcomings of traditional egocentric network data, the principal survey instrument consisted of 15 name generators selected as a result of a qualitative analysis of the patterning of interpersonal association in the Niakhar study area (Rytina et al. 2008). These name generators were designed to capture four key domains of association including affective, exchange, and role-relational ties as well as ties based on frequency of interaction (van der Poel 1993; Marin & Hampton 2007).[3] The number of network alters elicited by each name generator was not restricted, a standard constraint in other egocentric network designs. Respondents named, on average, 21.84 unique individuals as part of their personal networks across the 15 name generators, which represents a capture of larger and more complete personal networks than has ever been done before. The extensive nature of alter identification was made possible by omitting questions concerning alter characteristics such as their experiences with infant and child mortality. Higher quality data for named alters could be retrieved from the NDSS database. Several questions, however, were employed to assess attributes of the relationship between respondents and their network alters. For the purposes of this study, we will use one in particular, a psychophysical measure of tie strength (the subjective value of each alter to the respondent), to weight alter mortality experiences by closeness of their relationship to respondents (Rytina et al. 2008).

In order to link respondents to the mortality experience of their alters in the surveillance system, information concerning residence and mothers' and fathers' names was collected for each alter cited in the main instrument. This information was then used to match each alter to their fertility records. Overall, among the 2,363 alters elicited, 88% were uniquely identified in the surveillance system by this matching process. The fertility and mortality histories of the uniquely matched alters were taken directly from the fertility histories and surveillance data.[4]

[3]A full description of the name generators used is provided as part of the online supplement to this article, in Table 1a.

[4]A further 7% of named alters were identified by a maximum of two candidate-matches. Averaging mortality experience across these candidate-matches provides an unbiased, though noisy, source of information. Although these alters were omitted from the analyses reported here, preliminary analyses incorporating such averages did not result in any difference in substantive results.

The dependent variable and analytic sample—The full analytic sample for the present analysis consists of 133 respondents who completed the main NSNPS instrument and had at least 3 network alters identified in the surveillance data who had at least 1 live birth and also had valid data on the psychophysical measure of tie strength (described in-depth below concerning the construction of the network measures)[5]. On average, respondents in the analytic sample had about 10 alters in their networks (and a maximum of 33) with fertility data available from the NDSS. These alters were predominately of the same gender as respondents (73%). The restriction that alters must have some fertility experience makes them older, on average, especially for younger respondents. Despite this intrinsic bias, 49% of alters were within 10 years of age of respondents, while 13% were 10 or more years younger; 38% were 10 or more years older, on average. Social networks were highly localized, centered on respondents' compounds and radiating over adjacent, then distant, locales. Just over 40% of respondents' alters, on average, lived in the same compound as the respondent, with another 46% living in another compound in the same village. Only 8% of fertile alters came from other parts of the study zone outside the respondent's village. Though by definition we have restricted our analysis to network alters (both men and women) who had ever lived within the study zone and who had had at least one child, any bias produced by excluding others who never lived in the study area is probably not extreme. Only a relatively small proportion of alters cited in the NSNPS had never lived in the study area.[6]

Our measure of perceived infant and child mortality change comes from a question in the main survey instrument of the NSNPS which asked all respondents the following (deliberately) general question, similar to those used in early studies of the perception of mortality on fertility:

> "(do you think) that infant mortality has increased, decreased, or remained the same as previously?"

Just over two-thirds of respondents correctly perceived a decline in infant mortality relative to the past. One-quarter indicated that they believed mortality had increased, and seven percent believed it had remained the same. For the purposes of this analysis, we dichotomize this response with the reference category being those perceiving a downward trend, and the indicator category being a perception that infant mortality had stayed the same or increased relative to the past.

Independent variables: Fertility and Mortality Histories from the NDSS—The fertility and mortality histories for fertile members of the study population, which are used to measure village, compound, respondents', and network alters' experiences of perinatal and infant mortality, were drawn from the NDSS data. In 1983, when the initial census of the study area which forms the baseline of the current surveillance system was conducted, fertility histories consisted of the number of children born, the number that had died, and the number of perinatal deaths.[7] During the period from 1983 to 1997 similar fertility histories were collected for women who migrated into the study area. In all cases, after initial fertility

[5]Alters who had never had at least one child were excluded because their infant mortality experience (which in our model is hypothesized to influence perception of changes in mortality levels) is undefined. In order for mortality experience to enter into subjective perception through interaction, respondents' alters must at some time have been at risk of experiencing infant / child mortality.

[6]Overall less than 16% of respondents' alters, on average, had never lived in the study area. These alters were primarily found in two name generators designed to elicit geographically distal alters. These included 'people who are close and don't live around here' and 'people you talk with on the telephone'.

[7]Perinatal mortality is measured here as the number of children resulting from live births dying 'without a name'. Names are given to live births seven days after delivery.

histories were recorded, dates of births and deaths among residents of the study area were entered into the on-going surveillance system.

Child level records of deaths under eight days in the case of perinatal mortality and under 366 days in the case of infant mortality were aggregated to the individual mother.[8] The process of constructing individual level fertility histories for fathers was done in an identical fashion except where paternal identification was missing from either the fertility records of the NDSS or the fertility histories. In these cases identification was imputed based on dates of recorded unions to particular women for the period over which her fertility occurred.

Network mortality measures—The fertility histories thus constructed for all men and women who had had at least one child were then attached to the alters identified from responses to the network questionnaire. Independent variables used in the analysis here were constructed as follows. First, we measure the average (arithmetic mean) among all unique, fertile alters – identified across the 15 name generators in the survey – of the number and proportion of children lost in the first week and year of life, respectively.[9] These two measures are used to discriminate between potentially different effects related to the absolute and relative magnitudes of child loss within networks. Individuals' perception of mortality may be influenced, for example, by a great number of infant deaths among their social associates, though if the fertility of these network members is high the proportion of children lost may be relatively low. On the other hand, having alters who have lost a high proportion of their children, on average, may be influential regardless of the absolute number of children dying. To measure extreme mortality experiences, which may be especially salient or vivid to respondents (Montgomery 1998), we employ a second set of relative measures: that of the proportion of unique fertile alters who had lost greater than 20% of their children in the first week in the case of perinatal mortality and greater than 25% of their children before the age of one in the case of infant mortality. These cutoffs represent the approximate 90th percentile for each distribution in the population of fertile individuals in the surveillance system. Because infant and child mortality has declined so drastically in the study area we also use simple measures for the proportion of alters overall who had lost any child and, in the case of the analysis of infant mortality, an indicator for whether or not a respondent had any alter who had lost a child in the first week or year of life.

To address the second hypothesis, concerning the relative importance of more socially proximate network alters with regards to perceptions of infant mortality, we employ weighted variants of each of these network mortality measures, where the weights come from the psychophysical question asked in the NSNPS. This question asked respondents to assess the value of each alter on a scale of 0 to 100 relative to a random reference alter. The specific weight employed is the logarithm of each reported value, mean-centered for each respondent following the conventions of psychophysical scaling (Stevens 1986). In order to test the third hypothesis concerning the potential effects of more recent network mortality experience, network mortality measures identical to those described above were constructed

[8]It should be noted that in the case of births prior to 1983 for resident women and to 1997 for immigrants, infant (though not perinatal) mortality experience will be necessarily censored because dates of child deaths were not recorded. To address this, we estimated models of infant mortality experience before the onset of surveillance which are discussed in the text including imputed measures based on the number of total deaths, perinatal mortality, and period-specific infant mortality rates. The results were not substantively different from those presented here. This is likely because any such censored mortality experience happened at least 10 years prior to the survey.

[9]This 'synthetic' network encompasses alters from the multiple domains of association for which names were gathered here, excluding multiplexity, or multiple mentions of the same individual. While it would have been desirable to disaggregate this into its component domains of interaction, or even name generators, the small sample size of the pilot made this impractical. In such a situation, however, the synthetic network solution has previously been seen as acceptable (Knoke & Burt 1983).

to account for mortality experiences in the one year and five years prior to the survey data collection.

It should be noted that these measures represent information concerning perinatal and infant mortality *available* to respondents in forming perceptions of mortality change through their social networks as identified here. These are subject to possible error. Respondents may not know of, or remember, all or part of their alters' mortality experience for a variety of reasons, including the temporality of that experience and salience due to social proximity, effects which we attempt to model here. As argued above, however, with our approach this information is likely to be measured with less error than both information related to other behaviors or events often used in network learning models and homogenous measures of mortality context on the aggregate level. To the extent that random measurement error remains, its influence on our estimates will, on aggregate, be to attenuate identification of the relationships hypothesized.

Network Endogeneity and Individual level Controls—A serious concern in any social network analysis is the potential for network endogeneity. This can occur when network alters are selected for characteristics related to the independent variable. In this case, one might be concerned that network alters may have been selected by respondents based on their mortality experience or on some other structural characteristic strongly associated with their mortality experience. The former possibility is less of a concern here than it would be using other, less comprehensive, network instruments. It is unlikely, for example, that individuals select others who are 'closest to their heart', with whom they spend the most time in the dry season, or any of the other ties across the broad domains of interaction measured here (see Appendix table 1a included in the online supplementary material) based on their infant mortality experience.

To control for the second, indirect source of network endogeneity and to adequately model the potential influence of learning from network alters' mortality experiences on perceptions of mortality change as measured here, it is necessary to include structural covariates that could also influence these perceptions and which may simultaneously be associated with the network measures (c.f. Palloni 2001). A critical control of this type is respondents' own experience with child mortality, measured as the proportion of all children born alive which respondents had lost under the age of five. This is assumed in the following analysis to be zero for those respondents who had never had children and is expected to have a positive association with our measure of mortality perception. This measure is critical to include not primarily because of its independent association with perceptions of mortality levels, but because any number of unobserved factors could simultaneously influence own mortality experience and that of network alters. If uncontrolled, the associations between the network measures and mortality perceptions may be biased.

For similar reasons we also include individual level controls in the following analyses for: educational attainment (dichotomized as some schooling vs. none); whether respondents lived in one of the two large towns in sample; respondents' age, sex, and whether they believed it is more appropriate to deliver children at home, with a traditional midwife, or in a maternity clinic. This latter control taps respondents' beliefs concerning the efficacy of modern medical care *specifically* related to childbirth and early child health. Schemas concerning the efficacy of modern medical care have been seen to be intricately tied to those concerning mortality (Montgomery 2000). To the degree that such perceptions are associated with those held by their network alters it is necessary to control for these as they may influence alters' mortality experiences.

Homogeneous measures of informational context—To test the impact of homogeneous measures of contextual mortality experience relative to the individual level heterogeneous measures of network mortality we control for village and compound level perinatal and infant mortality rates during the five years prior to data collection. The temporal constraint on these measures was employed to more accurately represent recent experiences at these aggregate levels while avoiding problems associated with small numbers of relatively rare events. If these aggregate level measures of context are associated with mortality perceptions, we would expect those living in villages or compounds with higher levels of infant mortality to be more likely to perceive increasing or stable levels of infant mortality relative to the past.

Table 1 presents descriptive statistics for all variables used in the current analysis for the full perinatal loss and infant mortality samples as well as for the general population of the surveillance system aged 18–65 at the time the sample was drawn. There is a slightly higher proportion of females in our sample than in the general population (but not significantly so), and there is also a significantly higher proportion of respondents over 50 years of age. This latter difference is offset by fewer 18–25-year-olds than in the general population, though this difference on its own is not statistically significant. Additionally, our respondents come from compounds with slightly, though significantly, higher infant mortality in the previous five years than members of the general population. The age and sex differences likely have to do with the difficulty of contacting short-term labor migrants (who tend to be young males), but the reason for the higher compound level mortality is unknown. Aside from these somewhat minor differences, however, in whole the full sample is relatively representative of the population at large along these dimensions.

Results

Perinatal mortality among network alters

Table 2 presents logistic regression estimates (appropriate for a binary variable) of the likelihood of perceiving increased or unchanging infant mortality relative to the past by measures of network perinatal mortality and the controls.[10] The first panel presents the zero-order estimates of the dependent variable on the network measures of mortality. The second panel presents estimates including the full set of controls. In these and all following models, tests of statistical significance are one-tailed for own, village, compound, and network mortality measures because we have made explicit predictions concerning their direction.[11]

The baseline model (Model 1) is estimated with all controls including the measures of village and compound infant mortality during the previous five years. These latter two variables, as noted above, are key to a model of the effects of mortality context on perceptions (as well as fertility beliefs and behaviours), which assumes homogenous mixing with relation to information and experience within these areas. None of the coefficients for these or the controls are significantly different from zero. It is worth noting, however, that

[10]It should be acknowledged that in this (and the following) analysis, we present multiple specifications testing variants of the same hypothesis. While each measure is substantively different due to the denominator over which it is calculated or to the level of aggregation, in general multiple tests may lead to an increased probability of type I error, which the reader should take into account when interpreting the standard errors presented here.

[11]All multivariate models presented in this paper include the controls described above, though those for respondents' age, sex, town residence, educational attainment, and belief concerning the appropriate venue for childbirth are abridged here. The full tables are available in the accompanying online supplement, or from the corresponding author on request. Given the sample sizes used here, over-saturation of the models might be a concern. This was not a problem, however, and all model estimation terminated normally without errors. In addition to the zero-order estimates presented, models were also estimated with only the effects of own, village, compound, and network mortality measures. The results (not shown) indicate that the estimates of own, village, compound, and network mortality levels in all analyses are uniformly robust to the inclusion of the additional controls.

the direction of the coefficients for own, village, and compound mortality experience are in the expected directions.

The first measures of network perinatal mortality experience pertaining to the average number of perinatal deaths among network members are included in the specifications presented in Models 2 and 3. The former model assumes that all network alters' experiences are given equal weight in the construction of perceptions of mortality change. The latter model weights the experience of network alters by their relative proximity as measured by the psychophysical instrument. Both coefficients are positive, as expected, and both mediate somewhat the magnitude of the coefficients for village and compound infant mortality. The weighted measure, however, is almost twice the magnitude of its unweighted counterpart and is the only one of the two which is statistically significant. As modeled here, the predicted probability of perceiving, incorrectly, that infant mortality has increased relative to the past is 0.27 when respondents had no experience with perinatal death among alters and 0.36 when one-third of their alters' children had died during the first week of life.

Turning to the measure of proportion of network alters' children lost during the first week of life, we see that the coefficient for the proximity-weighted variant (Model 5) is again much larger than its unweighted counterpart (Model 4). Neither measure explains a substantial proportion of the village and compound coefficients, and neither is statistically significant – although the weighted version comes close by a one tailed test (p=0.165). The specifications of our next measure of network mortality experience – the proportion of network alters losing more than one-fifth of their children during the first week of life – are presented in Models 6 and 7. Coefficients for both the unweighted (Model 6) and weighted (Model 7) measures are large, and though only that for the weighted variant is statistically significant, that for the unweighted measure is close (p=0.116). Under the weighted model, the predicted probability of perceiving unchanging or increasing infant mortality increases from 0.28 when no alter had experienced extreme perinatal mortality to 0.45 when 20% of alters had – around the 95th percentile in our sample. Counter-intuitively, inclusion of these measures of network perinatal mortality is associated with a substantial, though non-significant, increase in the aggregate village level coefficient. It does, however, explain the compound level association more than any other previous measure.

Models 8 and 9 present specifications which test for the proportion of respondents' alters who had ever lost a child during the first week of life. Neither the weighted nor unweighted versions of this measure have a significant association with our measure of perceived mortality change. A simple model for whether respondents had any alter who had lost a child in the perinatal period (not shown) also yielded insignificant results. The explanation for these results may be that, though relatively rare, most respondents know someone who had lost a child in the perinatal period (see Table 2). When this loss happened, however, is another question. While it would have been desirable to address the potentially greater association of more recent experiences of perinatal loss directly, the relatively recent decline in this type of mortality makes this impractical.

This evidence provides some support for the first hypothesis concerning the effects of network perinatal mortality experience. Those respondents whose experienced higher numbers of perinatal deaths in their social networks and had higher proportions of alters in their networks who had lost many of their children during the first week of life were considerably more likely to believe that mortality had not declined relative to the recent past. Further, the second hypothesis that more socially proximate alters' experiences would be more strongly associated with mortality perceptions is also supported. In each case the specification with the mortality measure weighted by tie intensity is preferred over the unweighted measure.

Infant mortality among network alters

Though data constraints make the analysis of perinatal network mortality the cleanest possible here, infant mortality more generally is also of interest. In models with identical specifications to those presented in the perinatal analysis but using measures of infant mortality among network alters over their entire reproductive careers (not shown) only the weighted version of the measure of extreme infant mortality among network alters was statistically significant. This result is, however, questionable because of the issue of censoring of infant mortality before dates of death for all children were collected. It also leaves unaddressed the hypothesis concerning the recency of mortality experiences among alters. Turning to this question, we restrict the analytic sample further to those respondents who had at least one alter who had had a live birth during the previous year (that is, those who had an alter at *risk* of experiencing a child death during the last year) and investigate the association between network infant mortality in that period and mortality perceptions. Doing so not only addresses the recency hypothesis but eliminates potential censoring effects, in that it only examines infant mortality during the period for which accurate dates of birth and death for all children were collected. Unfortunately, this further restricts our sample size, in this case to 98 respondents. Table 3 presents specifications of the likelihood of perceiving unchanging or higher infant mortality for this sub-sample, including both unweighted measures of infant deaths in the prior year and the same measures weighted by the psychophysical measure of social proximity.

The baseline specification including only the individual level controls and village and compound infant mortality for these respondents is presented in Model 1. As in the perinatal analysis, none of the controls is statistically significant. Of note here, however, is that while the magnitude of the village level infant mortality coefficient is still quite large, that for compound infant mortality is close to zero. Models 2 and 3 add to this the unweighted and weighted measures for average number of infant deaths among alters during the last year; Models 4 and 5 the analogous models for proportion of infant deaths among alters during the last year. In all cases the models with the unweighted mortality measures fit better than their weighted variants and the coefficients for both unweighted specifications are statistically significant. The network mortality coefficients are also large, in Models 6 and 7, for the proportion of alters having experienced infant mortality during the previous year. Though neither is statistically significant, both come close to being so (unweighted p=0.114, weighted p=0.105). Finally, Model 8 is a specification with a simple binary variable for whether any alter had lost an infant during the last year.[12] The coefficient for this measure is positive and highly significant. The predicted probability from this model when no alter had experienced an infant death during the year was 0.26. When an alter had, it was 0.80.

The models presented here provide tentative evidence that very recent infant mortality has some impact on perceptions of change in mortality levels.[13] As noted above, in these models those unweighted for social proximity fit better than their weighted counterparts. Why this should be so in this case when it was not in the analysis of perinatal mortality is an open question. One possibility is that alters' infant mortality experiences over their entire reproductive careers may have a greater impact on mortality perceptions when those alters are more socially and potentially affectively close to respondents, while recency effects

[12]This measure is unaffected by the psychophysical weighting, thus we present only one estimate.

[13]The sample is quite small, however, and though infant mortality is perhaps most salient, it was relatively rare at the time of the survey and does not capture what are perhaps broader influences of child mortality. To see if the potential influence of recent child mortality was similar, we estimated the same models using network measures of mortality to children under the age of five during the last year on this subsample (not shown). The results were indeed similar, with the specifications using unweighted measures of network mortality fitting better than those that were weighted by social proximity. The probability of perceiving a constant or increasing level of infant mortality was 0.25 when no alter had lost a child under 5 during the previous year and was 0.48 when at least one had.

outweigh any salience effects due to social proximity. If this were the case, we should see weighted models of longer term mortality experience fit better than their unweighted counterparts, yet as in the models presented here, unweighted measures outperform weighted ones for more recent experience. A direct test of this hypothesis with regard to network infant mortality experience was suggestive, yet inconclusive. Models including measures of the infant mortality experience of alters over their entire reproductive span and during the last 5 years were estimated on this subsample (not shown). As in the analysis of infant mortality experience for the entire sample discussed above, however, only the proximity-weighted variant of extreme infant mortality experience across the reproductive career fit the data significantly better than its unweighted analogue. Taken together with the results from Table 3 and the perinatal analysis, these results lend suggestive support to the speculation that recency of mortality experience may trump the impact of social proximity in its integration into subjective perceptions of mortality levels in the short term, but the longer-term experiences of more socially proximate alters may also have an impact. Further research using larger samples, especially concerning perinatal mortality experience, should be able to definitively test these relationships.

Summary and conclusions

We began this piece with a theoretical argument that subjective perception, which structures the context for and potentially motivates individual action, is shaped by heterogeneous individual level experience. We have attempted to test such a linkage here, of the heterogeneous environmental experience of perinatal and infant mortality and perception of the force of that mortality.

There are a number of important limitations to the present research. First and most obvious is the relatively small sample size. While it would have been preferable to have a larger sample, the NSNPS was a pilot study designed to test new methodologies for gathering extensive, high quality egocentric network data. Nonetheless, it should be noted that the sample size here is not much smaller than in other demographic network studies employing name generators to elicit alters which do not benefit from the advantages of the present design.

In addition to the small sample size, there is no doubt of measurement error with regard to mortality at the alter level. Further, unique identification of alters identified through the name generators used, though high, was not perfect, and the way fertility histories were collected in the surveillance system makes definitive dating of infant deaths prior to 1983 (and 1997 for immigrant women) impossible. We have argued here, however, that mortality is relatively easy to perceive compared to other social phenomena; that our measurement is more precise than possible with other instruments; and that any influence of random measurement error stemming from these sources would likely be to suppress identification of results supporting our hypotheses.

On a more general level, though we have made the broader theoretical argument that schemas concerning child survival and mortality are developed and updated through heterogeneous interaction, the perception of mortality as measured by our survey question surely does not adequately measure such schemas. Schemas are complex interpretive frameworks for the cognitive integration of experience and action, any one of which – as noted earlier in the paper – is enmeshed in networks of hierarchical and non-hierchical associations with others. If one conceives of schemas as latent constructs, then our measure of mortality perceptions is likely a good indicator of some aspect of an infant mortality schema, but only one of potentially numerous others. To more adequately address the question of the impact of how schemas concerning infant mortality and survival are constructed, more sophisticated measurements of them and associated schemas (such as the efficacy of modern medical treatment) will be necessary, likely through the latent construct model.

Despite these limitations, these data have advantages virtually no previous egocentric network data does. They combine more extensive alter identification than previously feasible across multiple domains of interaction with pre-existing, prospectively collected, data from the alters themselves and with extensive measures of tie strength such as the psychophysical measure of proximity employed here. These advantages address some of the most critical problems in previous egocentric network analysis related to limitations on domains of interaction studied, artificial truncation of networks, and biases arising from ego reports of alters' behaviors and characteristics.

The results presented here tentatively support the hypothesis that heterogeneous experience of perinatal and infant mortality in individuals' social networks is associated with perceptions of change in infant mortality levels. These effects are relatively strong in the zero-order associations and after controlling for a number of individual level structural covariates possibly associated with the infant mortality experience of network alters which did not influence the likelihood of perceiving constant or increasing infant mortality as much as the network measures.

In no case were the aggregate measures for village and compound level infant mortality rates significantly associated with perceptions of change in infant mortality by respondents. They were, however, consistently positive, as one would expect if they are poorly measured proxies for heterogeneous individual experience within those areas. Further, in most cases where network mortality experience was significant, its inclusion in the model specification drew down or eliminated these contextual effects. Such measures encompass the average experience of everyone in a particular area, including those an individual is not particularly close to, does not know, or never interacts with. Thus, for some, their particular experience will be lower than the aggregate; for some it will be higher; but for none except those whose interactional experience coincides with that of the aggregate will it be particularly well measured.

Substantively, this research builds on a cognitive model that views subjectivity as formed through particular experiences over time and addresses the long neglected linkage between contextual infant and child mortality and how people come to perceive the likelihood of child survival. Perceptions of declining infant and child mortality are a key mechanism leading to lower fertility in many models of the demographic transition. As we have seen here, despite a manifest and spectacular reduction in infant and child mortality across the entire population of the Niakhar study area, close to one-third of respondents surveyed failed to perceive this, believing that infant mortality had either stayed the same as in the past or had increased. Why is this the case? A large part of the story, as Montgomery has suggested, probably has to do with the way human cognition works. People tend to make inferences based on central tendencies from small samples of information, where the samples are often drawn through decidedly non-random interaction with others. Such a strategy is obviously cognitively efficient relative to more intensive strategies and may also be well adapted to the type of information that is most commonly available and most pertinent to people's particular circumstances.

In a population level context of declining mortality, where there is significant variation in individual experiencesmany people will have someone who has lost one or several children in their direct experience (McNicoll 1986), that from which they draw their informational sample. This research suggests that this type of interpersonally available information may have a lasting impact on people's mortality perceptions long after mortality levels have begun to decline in cases where the network members who experience this mortality are especially close to them. It also suggests that any recent experience in people's networks, regardless of their social proximity, may also have a disproportionate influence. This points to the potential influence of 'weak' ties in raising perceptions of risk even when mortality is low among more socially proximate alters. Taken together, these results may provide part of the explanation for lags between mortality and fertility declines, as suggested elsewhere (Sandberg 2006). A policy implication here is that to lower *perceived* mortality levels (which may be linked to fertility behaviors and family-level labor decisions and investment strategies) a reduction in the variability of mortality experience (particularly recent) within social networks may be necessary (c.f. Sandberg 2005, 2006). This may be one of the reasons behind the success of programs such as the Community-Based Health and Planning Services (CHPS) project in northern Ghana where intensive, community-based health services brought down infant and child mortality as well as fertility dramatically (Phillips et al. 2006; Binka et al. 2007). Though, no doubt, community-level provision of contraception played the major role in fertility reductions, the comprehensive health interventions may also have served to lower the variability of within-network mortality experience by ameliorating conditions for a greater number of network alters (who may be widely dispersed) than would have been the case if interventions had focused only on major towns or health centers.

Of course, we may well ask at this point, why should we care about mechanisms linking mortality and fertility in demographic transitions anymore? In most parts of the world outside of sub-Saharan Africa, where the data for this research were collected, the first demographic transition has long been completed. Though we obviously should still care about understanding mechanisms influencing fertility and population growth in currently transitional populations, the broader reason we suggest is that our results are concordant with the basic premise of the connectionist model of learned subjectivity forwarded earlier. This type of model is central to a large number of theoretical perspectives in the social sciences which hold individual subjectivity to be at least in part a function of heterogeneous interaction with *particular* others. What makes broader interpretive frameworks – schemas – built upon and informed by heterogeneous interaction important to understand is their power to frame individuals' decision making options and potentially motivate their actions more generally.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- > We model survey respondents' perception of change in infant mortality levels in rural Senegal.
- > Network perinatal and infant mortality experience is associated with mortality perceptions.
- > Heterogeneous network experience explains perception better than community level context.

Social proximity and recency effects related to network experience are identified.

Table 1

Descriptive statistics for variables used in analysis

	Perinatal loss full sample (n=133)		Infant loss ego w/fertile alters in prior year (n=98)		NDHSS Age 18–65 (N=17257)	
	mean	**sd**	**mean**	**sd**	**mean**	**sd**
Perceive infant mortality as increasing or staying the same	0.320	0.468	0.286	0.454	-	-
Control variables						
Sex (0=female)	0.414	0.494	0.388	0.490	0.499	0.500
Age group (18–25 years=0)	0.271	0.445	0.245	0.432	0.344	0.475
26–33 years	0.226	0.419	0.245	0.432	0.231	0.421
34–49 years	0.241	0.429	0.296	0.459	0.256	0.437
50* years	0.263	0.442	0.214	0.412	0.168**	0.375
Town residence (0=village)	0.323	0.470	0.327	0.471	0.274	0.446
Any schooling (0-none)	0.150	0.359	0.153	0.362	0.147	0.355
Childbirth best in clinic (0=no)	0.654	0.477	0.673	0.471	-	-
Proportion own children died under 5	0.094	0.158	0.090	0.159	0.086	0.162
Infant mortality village	0.039	0.020	0.027	0.016	0.039	0.014
Infant mortality compound	0.062	0.144	0.013	0.104	0.035	0.098
Network perinatal/infant mortality measures						
Average number of deaths among alters (unweighted)	0.121	0.150	0.011	0.059		
(weighted)	0.140	0.212	0.012	0.073		
Average proportion deaths among alters (unweighted)	0.020	0.035	0.055	0.044		
(weighted)	0.023	0.045	0.027	0.138		
Proportion alters with extreme loss (unweighted)	0.029	0.065	-	-		
(weighted)	0.034	0.102	-	-		
Proportion alters with any loss (unweighted)						
(weighted)						
Any alter had loss (unweighted)	0.571	0.497	0.051	.221		
(weighted)	0.564	0.498	0.051	221		

Source: compiled by author

Notes: Significant difference from the full sample,

* $p < .05$

** $p < .01$

Table 2

Likelihood of perceiving increased or unchanging infant mortality by village and compound infant mortality, perinatal mortality among social network alters and controls: n=133 (std. error)

	M1	M2	M3	M4	M5	M6	M7	M8	M9
Zero- order network mortality coefficients		*0.968 (1.217)*	*1.365* (0.856)*	*1.720 (5.161)*	*5.038 (3.995)*	*4.032* (2.772)*	*3.927** (2.174)*	*−0.138 (1.594)*	*0.873 (1.041)*
Proportion own children died under 5	0.276 (1.372)	0.221 (1.386)	0.204 (1.397)	0.275 (1.372)	0.259 (1.382)	0.146 (1.402)	0.159 (1.409)	0.291 (1.371)	0.259 (1.378)
Infant mortality village	2.762 (11.724)	2.226 (11.796)	2.073 (11.928)	2.740 (11.742)	2.604 (11.809)	3.467 (11.862)	4.331 (12.060)	3.130 (11.803)	2.181 (11.805)
Infant mortality compound	1.511 (1.324)	1.471 (1.329)	1.406 (1.340)	1.510 (1.324)	1.444 (1.329)	1.381 (1.345)	1.293 (1.355)	1.513 (1.325)	1.496 (1.326)
Average number of perinatal deaths among alters		0.672 (1.253)	1.208* (0.890)						
Average proportion perinatal deaths among alters				0.187 (5.339)	4.004 (4.137)				
Proportion alters with extreme perinatal loss						3.458 (2.897)	3.541* (2.182)		
Proportion alters any perinatal loss								−0.434 (1.631)	0.731 (1.075)
Any alter had perinatal loss									
Constant	−1.206	−1.257	−1.326	−1.210	−1.314	−1.405	−1.477	−1.181*	−1.257
Log-likelihood	−81.08	−80.93	−80.14	−81.08	−80.6	−80.36	−79.46	−81.04	−80.85
BIC	215.95	220.55	218.97	220.84	219.89	219.4	217.6	220.77	220.38
chi2	3.74	4.02	5.61	3.74	4.69	5.18	6.97	3.81	4.19

Source: compiled by author.

Notes: Controls estimated for sex, age group, town residence, any schooling and opinion concerning best place for childbirth are omitted for each model.

* $p<0.10$

** $p<0.05$

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Table 3

Likelihood of perceiving increased or stable infant mortality by village and compound infant mortality, infant mortality among social network alters who had a birth in the last year and controls (n=98)

	M1	M2	M3	M4	M5	M6	M7	M8
Zero- order network mortality coefficients		*7.923**	*4.728*	*5.878***	*3.823**	*7.666**	*4.628*	*2.442***
		(5.572)	*(3.807)*	*(3.229)*	*(2.331)*	*(5.899)*	*(3.860)*	*(1.143)*
Proportion own children died under 5	0.740	0.683	0.688	0.839	0.618	0.688	0.692	0.940
	(1.653)	(1.675)	(1.672)	(1.691)	(1.681)	(1.677)	(1.674)	(1.683)
Infant mortality village	9.378	4.000	5.434	1.492	2.366	4.131	5.364	1.920
	(15.376)	(15.937)	(15.791)	(16.155)	(16.060)	(15.927)	(15.779)	(16.197)
Infant mortality compound	−0.005	−0.431	−0.418	−0.345	−0.265	−0.502	−0.489	−0.190
	(1.601)	(1.760)	(1.733)	(1.797)	(1.734)	(1.789)	(1.758)	(1.725)
Average number infant deaths among alters in last year		7.288* (5.325)	4.483 (3.750)					
Average proportion infant deaths among alters in last year				6.219** (3.472)	3.750* (2.494)			
Proportion alters lost infant in last year						6.808 (5.418)	4.368 (3.623)	
Any alter lost infant last year								2.510** (1.212)
Constant	−1.920*	−1.789*	−1.827*	−1.819*	−1.705*	−1.798*	−1.831*	−1.892*
Log-likelihood	−57.02	−55.59	−56.09	−53.84	−55.17	−55.44	−55.92	−54.28
AIC	136.03	135.18	136.19	131.69	134.34	134.89	135.84	132.56
BIC	164.47	166.20	167.21	162.71	165.36	165.91	166.86	163.57
chi2	3.23	6.08	5.07	9.57	6.92	6.37	5.42	8.71

Source: compiled by author.

Notes: Controls estimated for sex, age group, town residence, any schooling and opinion concerning best place for childbirth are omitted for each model.

* $p<0.10$,

** $p<0.05$