Reports

Are Affines Treated as Biological Kin?

A Test of Hughes's Hypothesis

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Affines (or "in-laws") have long been recognized within anthropology as a special kind of kin. Evolutionary biology, in contrast, has typically treated affines as though they were unrelated: only direct genetic kinship counts. However, Hughes (1988) argued that Hamilton's concept of inclusive fitness naturally includes affinal kin as kin because true kin and their affines share genetic interests in future generations. We test this proposal by asking whether affinal relatives are treated more like biological kin or unrelated friends in terms of perceived emotional closeness. We show for a sample of contemporary Belgians that affines are indeed treated more or less the same as biological kin of similar nominal relatedness and not at all like unrelated friends. These findings suggest that Hughes was right in his reinterpretation of Hamilton and that affinal kinship needs to be considered in biological studies of human kinship.

Anthropologists have long recognized a distinction between familial (i.e., true biological) kin and affinal kin (i.e., in-laws, or relatives acquired through marriage). While biological kinship has played a very significant role in evolutionary anthropology ever since Hamilton's (1964) development of the concept of inclusive fitness, affinal kinship has largely been ignored other than as a limited interest in grandparental investment patterns (Beise and Voland 2002; Sear and Mace 2008; Sear, Mace, and McGregor 2000). However, in a little-appreciated analysis, Hughes (1988) pointed out that the logic of Hamilton's conception of inclusive fitness had more significant implications than usually appreciated, especially for humans with their long life span and multiple overlapping

generations. Because fitness is concerned with maximizing genetic representation in future generations, shared genetic interest is not just a matter of descent from a common ancestor but must also involve future reproductive opportunities. In other words, Fisher's (1930) reproductive value must play a significant role in fitness calculations and hence in terms of "inclusive kinship." Hughes (1988) showed that the proper focus of inclusive fitness should be shared genetic interest in the current pubertal generation (the cohort that is just about to start reproduction) rather than shared genetic interest in a past ancestor. The latter, he argued, merely provides a convenient anchor off which to hang the former in a context where the locus of genetic interest is constantly shifting through time as each successive cohort of offspring is born.

Hughes (1988) showed that many of the apparent anomalies in human kinship terminology (i.e., cases where social kinship appears to cut across biological kinship, many of which have been used to discredit the relevance of biological kinship to the ethnographic context) were readily explained by the fact that individuals had shared genetic interests in the current pubertal generation; indeed, an individual might have greater common genetic interest in key members of the offspring generation with in-laws than they did with at least some of their biological kin. This is, he argued, because inclusive fitness in the Hamiltonian sense is the intersection of conventional biological kinship (based on pedigree and descent from a common ancestor) and reproductive value. Fitness is maximized by balancing these two dimensions. In many respects, Hughes was merely reemphasizing Hamilton's point that conventional biological kinship is simply one component of inclusive fitness. Hamilton's original conception of "neighbour modulated fitness" explicitly emphasized this, reinforcing the point that inclusive fitness is sometimes maximized by cooperating with biologically unrelated individuals to the detriment of biological relatives. Indeed, monogamous pair-bonds represent the archetypal example of this: two unrelated individuals cooperate in order to reproduce and therefore sometimes behave altruistically toward each other.

We test Hughes's hypothesis using data on egocentric social networks to ask whether individuals treat affinal kin more like biological kin or more like unrelated individuals. For this purpose, we use contact frequency and emotional closeness (EC) as an assay for social engagement and willingness to cooperate and ask whether the pattern observed for affines is more similar to that for true biological kin or to that for unrelated friends. Curry, Roberts, and Dunbar (forthcoming) have shown that EC correlates with willingness to behave altruistically toward members of one's personal network. Roberts et al. (2009) used the time in days since last contact as a proxy for contact frequency and found that within people's total active social network (defined as all alters contacted within the past year), there is a negative relationship between EC (measured on a Likert scale from 1 to 10) and time since last contact (of any type), with a decrease of one unit of EC

for every 13 days since the last contact. Within this broad pattern, Roberts et al. (2009) found that friends have a significantly lower intercept and shallower slope than kin (fig. 1), suggesting that it is necessary to work harder to maintain friends within one's social network. Here we ask whether the pattern relating EC and time since last contact for affines more closely resembles that for biological kin or that for unrelated friends or follows a separate intermediate pattern, assuming (as is conventional) that natural selection will adjust proximate mechanisms such as EC to prioritize those relationships that will maximize fitness.

Methods

Participants

The data are based on complete network questionnaires completed by 161 adults recruited during 2004–2005 in Belgium. Because of the length of the questionnaire (typically, it takes up to 2 hours to complete), snowball and opportunity sampling methods were used (Roberts et al. 2009). Because consistent gender differences have been found in male and female networks (Dunbar and Spoors 1995; Roberts et al. 2008), the sample was restricted to female respondents in order to eliminate such effects and allow for a more detailed examination of other factors that affect personal networks. However, respondents could list friends and relatives of both sexes as members of their social networks. Respondents ranged in age from 18 to 63 years (mean = 37.78, SD = 13.10); 77% of the sample had completed higher education, 68% were working (part time or full time), and 83% had a partner. This database has previously been used to examine the effect of childlessness on social investment in kin (Pollet, Kuppens, and Dunbar 2006) and constraints on network size (Roberts and Dunbar 2010; Roberts et al. 2009).

The Social Network Questionnaire

We used a social network questionnaire to measure the active networks (number of alters contacted within past 12 months) of individual egos (participants). Participants were asked to provide demographic information including age, highest educational qualification, occupational status, and marital status. Participants were asked to list all their known and living relatives, including their affinal kin. Affinal kin were defined as the genetic kin of their spouse or "long-term partner" (e.g., husband's sister) or the partners of their genetic kin (e.g., sister's husband). Respondents were also asked to list other unrelated people in their network ("friends") with whom they considered that they had a personal relationship and for whom all of the following three conditions applied: (i) they had contact details, (ii) they had contacted them
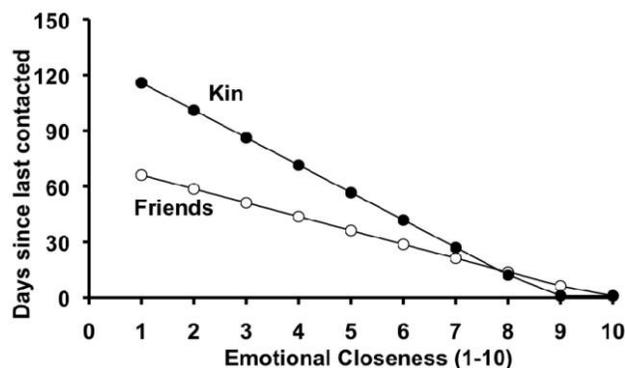

Figure 1. Mean days to last contact plotted against emotional closeness category separately for kin (biological and affinal combined) and friends. Data points on fitted lines are derived from parameter estimates of fixed effects. Redrawn from Roberts et al. (2009).

within the past 12 months, and (iii) they felt they would wish the relationship to continue. Respondents were asked to look through any lists of addresses (telephone address book, e-mail address book, handwritten address book, list of telephone numbers) to prompt their memory. For each alter, respondents were asked to say (i) how emotionally close they felt toward him or her on a scale of 1–10 (10 = highest) and (ii) when they last made face-to-face contact with him or her.

Kinship

Participants were asked to specify their exact relationship to all biological and affinal kin. We used these statements to calculate genetic relatedness in the conventional way for all biological kin. Using Hughes's (1988) reasoning, we calculated coefficients of nominal genetic relatedness (which, for convenience, we will term Hughes relatedness, or r_{Hughes}) for affinal relatives by asking what shared reproductive interests they have with ego (fig. 2). Strictly speaking, r_{Hughes} is a conventional coefficient of relatedness to ego calculated through the descendent pedigree rather than through the ancestor pedigree (as would be conventional for calculating biological relatedness). Ego's husband's sister, for example, has a shared genetic interest in her brother's offspring and, through this, a nominal genetic relatedness to her brother's spouse (ego) equivalent to her biological relatedness to her brother's offspring ($r_{Hughes} = 0.5 \times 0.5 = 0.25$). Because all such r_{Hughes} will scale equivalently, for convenience we have opted here to calculate ego's r_{Hughes} to her affines as her conventional biological relatedness to her spouse's relatives or equivalently for any other biological relative's affines (i.e., sibling's spouse or sibling's spouse's relatives), bearing in mind that each will be one degree of r_{Hughes} closer than it should be. In other words, a sibling's spouse is treated as having the same nominal relatedness to ego as his or her sibling (i.e., $r_{Hughes} = r = 0.5$, assuming siblings are full relatives). Doing so will make
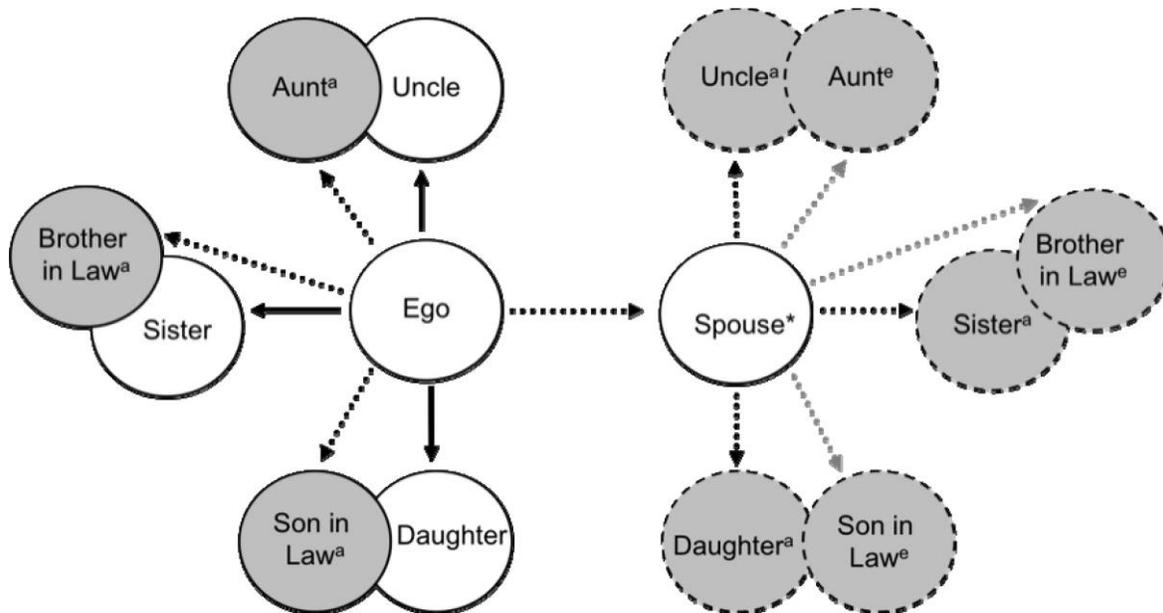
Figure 2. Some of the possible relationships an ego might have with kin alters. Solid arrows link between the ego and his or her genetically related kin (white circles); dotted arrows link the ego to affines (gray circles). a = affines (solid-edged circles = affines inherited through family; dotted-edged circles = affines inherited through a spouse/partner); e = spouse affines that were excluded from general analyses; see text for details.

it easier for the reader to equate relatives for generational equivalence in the analyses that follow.

Analyses

For the purposes of the present analyses, we excluded any alter who had a contact time >365 days, partners/spouses (as they are affines with an EC rating of 9–10 and daily contact), and partner's affines (e.g., an ego's spouse's brother's spouse but not the spouse's biological kin; see fig. 2). We used a linear mixed model (LMM) analysis to control for the covariance within each subject's social network, with each ego as a subject and alter as the repeated measure (with a scaled identity covariance structure). Random effects were fitted with ego as the subject and using a diagonal covariance structure. We used Akaike Information Criterion (AIC; Akaike 1974) to assess the fit of alternative nested models and thus to determine whether any increases in model complexity were justified. We started with the most basic of models and progressively expanded the model's complexity by adding terms, using the corresponding change in AIC to justify any increase in the number of model parameters. This way we can compare the relative merits of nested terms as significant main effects while being confident as to whether any subdividing of alter classes was truly an improvement to the model. All analyses were conducted using SPSS, version 16.0.

Results

The simplest model confirmed that the time since last contact (in days) was negatively associated with an increase in EC (table 1; LMM 1: $F_{1,169.7} = 338.9$, $P < .001$; days since last contact $= 114.7 - 13.0 \times EC$). This relationship also held when controlling for the sex of the alters ($F_{1,10,587} = 0.863$, $P = .353$), ego's age ($F_{1,143} = 1.0$, $P = .317$), the travel time to the alter (time to last contact significantly increases with travel time: $F_{1,10,120} = 57.9$, $P < .001$), and whether the ego was single (singles contacted alters significantly more recently than non-singles [$F_{1,162} = 5.1$, $P = .026$] and with a shallower slope with EC [$F_{1,179} = 4.6$, $P = .033$]). We then reran the basic model with the inclusion of the primary subdivision between friends and kin (including affinal kin) as used by Roberts et al. (2009). This yielded a significant improvement in the model (table 1, LMM 2); moreover, as previously shown, the slopes and intercepts for friends differ from those for kin (genetic and affinal relatives pooled; LMM 2: kin vs. friends: $F_{1,11,331} = 251.9$, $P < .001$; kin, days since last contact $= 130.6 - 14.8 \times EC$; friends, days since last contact $= 73.6 - 7.5 \times EC$).

We then subdivided kin into genetic and affinal relatives. This step yielded further improvement in model fit (table 1, LMM 3), but while the classification system was significant,

Table 1. Summary statistics and comparisons of different models for the relationship between ego and alters

Model	Description	AIC	Change from null model
LMM 1 (null)	EC only (null)	115,137	
LMM 2	Kin and friends by EC (Roberts et al. 2009)	114,423	−714
LMM 3	Kin split into genetic and affinal	114,274	−149
LMM 4 a + b (null)	EC and Hamilton values, nonfriends only	(a) 59,842 (ordinal)	
		(b) 60,163 (scale)	
LMM 5 a + b	EC and Hughes values, nonfriends only	(a) 59,532	−310
		(b) 59,755	−408
LMM 6 a + b	Same as LMM 5 PLUS relative generation level	(a) 59,383	−149
		(b) 59,501	−254

Note. AIC = Akaike Information Criterion; LMM = linear mixed models; EC = emotional closeness.

the parameter estimates indicate that neither the slope nor the intercept for affines was statistically different from those of genetic kin (fig. 3; LMM 3: affinal/genetic/friends: $F_{2,856} = 91.9$, $P < .001$; genetic: days since last contact = $139.8 − 15.4 \times EC$; affinal: days since last contact = $132.3 − 14.4 \times EC$; difference in intercepts: $t = 1.674$, $P = .095$; difference in slopes: $t = 1.604$, $P = .109$). These results also held when controlling for alter sex, travel time to alter, ego age, and ego relationship status, with no qualitative differences emerging between the models (statistics not shown).

Next, we dropped friends from the analysis and fitted a separate slope for biological kin of each value of genetic relatedness ($r = 0.125$, 0.25, or 0.5) and compared each of these three slopes with the mean slope for affines in order to ask whether affines are, on average, treated more like immediate family or more distant family. Not surprisingly, the lower the genetic coefficient, the greater the time to last contact (fig. 4; statistically verified by fitting r as a scale variable along with EC and the interaction (LMM: r, $F_{1,998} = 118.6$, $P < .001$; slope = $−289.4$). A significant interaction between EC and the different genetic coefficients suggested that the slopes were different for at least one pairing (table 1, LMM 4 a: $F_{3,1,178} = 22.1$, $P < .001$). Pairwise comparisons between the estimated marginal means indicate that affines, who have a coefficient of true genetic relatedness of $r = 0$, are treated in a way that is indistinguishable from biological relatives with a coefficient of relatedness of $r = 0.25$ ($P = .288$). They are contacted more frequently than biological kin of $r = 0.125$ (95% confidence interval [CI] = 17–37 days sooner, $P < .001$) and less often than biological kin of $r = 0.5$ (95% CI = 9–28 days later, $P < .001$).

The mean r_{Hughes} to ego's affines is $r_{Hughes} = 0.295 \pm 0.151$ SD, which does not differ significantly from 0.25 ($Z = 0.267$, $P = .787$). Note, however, that this is significantly higher than the mean relatedness for genetic kin ($r = 0.273 \pm 0.148$: ANOVA, $F_{1,5,411} = 28.5$, $P < .001$). We then fitted either the Hamilton values (table 1, LMM 4 a + b) or the r_{Hughes} values (table 1, LMM 5 a + b) and compared the model fit scores with AIC as before. Whether the values were fitted as nominal factors or as scale variables, the Hughes model was always superior, suggesting that affinal alters are

indeed treated as though they were biological relatives (see table 1).

There is a further improvement in goodness of fit if the relative generation level of alters to ego is included in the model (table 1, LMM 6 a + b: generation: $F_{2,939} = 15.1$, $P < .001$). This reflects the fact that not only do egos invest more in alters with larger r_{Hughes} values but also they invest more in alters from the generation below (estimated marginal mean of time since last contact for EC = 5.22 is 28.5 days) as compared with the same generation (55.4 days: pairwise comparison, $P = .007$) or the generation above (45.0 days: pairwise comparison marginally nonsignificant, $P = .063$). This offers further evidence in support of the claim that people's behavioral investments in their social relationships maximize their inclusive fitness, because as Hughes (1988) argued, they are sensitive to both the reproductive value of alters and the shared reproductive interests of genetically unrelated alters. For comparison, we ran the same analysis for friends to determine how individuals of relatedness $r = 0$ compare with the different values of true genetic relatedness: $r = 0.125$, 0.25, 0.5. The results show that friends are treated significantly differently from all three classes of relative (pairwise com-
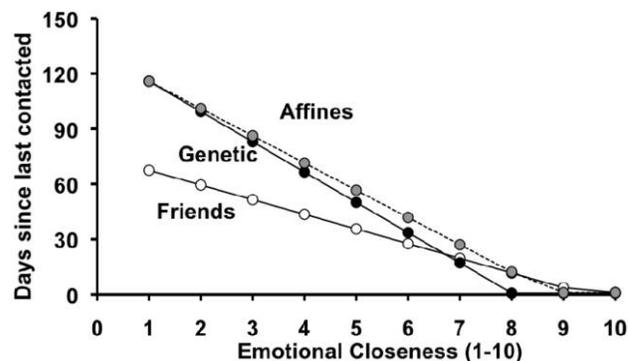

Figure 3. Mean days to last contact plotted against emotional closeness category separately for biological kin, affinal kin, and friends. Black circles are genetic kin; gray circles with dotted line are affines; white circles are friends. Data points on fitted lines are derived from parameter estimates of fixed effects.
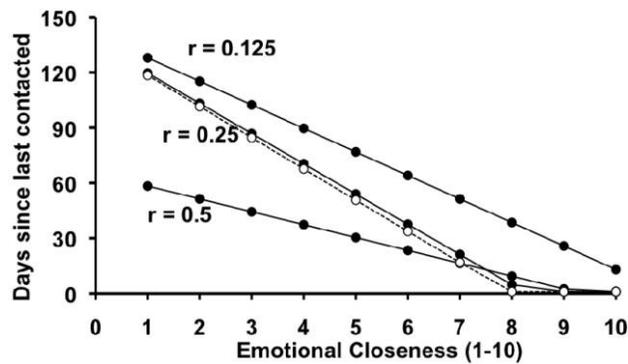
Figure 4. Mean days to last contact plotted against emotional closeness category for individual relatedness categories for biological kin (filled symbols: $r = 0.5$, $r = 0.25$, and $r = 0.125$) and all affinal kin (open symbols with dashed line). Affines are treated almost exactly as though they were related to ego as $r = 0.25$. Data points on fitted lines are derived from parameter estimates of fixed effects.

parisons: friends vs. $r = 0.125$, $P < .001$; vs. $r = 0.25$, $P = .005$; vs. $r = 0.5$, $P < .001$).

Finally, we fitted a model with EC, the Hughes values, and whether the alter was genetically related. This way we could test whether affines really were treated like kin while controlling for the degree of relatedness or r_{Hughes}. Neither the intercept (table 2; genetic [yes/no] $\times$ r_{Hughes}; $F_{2,4,203} = 0.93$, $P = .394$) nor the slope (genetic [yes/no] $\times$ r_{Hughes} $\times$ EC: $F_{2,5,157} = 0.64$, $P = .530$) was affected by the distinction between genetic/nongenetic. The distinction was not significant even when controlling for the level of relatedness and r_{Hughes} (table 2; $F_{1,166} = 0.002$, $P = .969$).

Discussion

Kinship has been an important category in anthropology since its inception as a discipline. However, the emphasis within evolutionary anthropology has focussed exclusively on biological (or genetic) kinship, and affinal (or in-law) kinship has been all but ignored. We have demonstrated here that at least in terms of the pattern of contact and the expressed degree of EC, affines are treated in ways that are much closer to biological kin than to unrelated friends in a sample of contemporary Europeans. Actively contacting an alter or meeting up with them face-to-face involves time and commitment, and how often an ego contacts alters is thus a measure of his or her investment in that alter. In our sample, the ways in which affines and biological kin are treated are statistically indistinguishable, and both are very different from the way friends are treated (fig. 3). In effect, people treat affines as biological kin rather than as unrelated friends because, we suggest, as argued by Hughes (1988), in-laws share with ego a common genetic interest in future generations.

The slope of the relationship between our index of EC and time since last contact for affines was statistically equivalent

to the slope for biological kin with a coefficient of relatedness of 0.25 (i.e., grandparent to grandchild or niece/nephew to aunt/uncle). This could mean that affines are generally treated as equivalent to medium-close relatives or that the affines in our study had a mean r_{Hughes} of 0.25. This conclusion is supported by the fact that including r_{Hughes} values gave a significantly improved model fit compared with either using just true (biological) relatedness values or using a three-way distinction between friends, affines, and kin. Note that in none of the analyses were biologically unrelated friends treated in any way the same as either biological kin or affines.

The actual mean r_{Hughes} coefficient for affines ($r_{\text{Hughes}} = 0.295$) was significantly higher than the mean coefficient for genetic kin in the sample ($r = 0.273$; ANOVA, $F_{1,5,411} = 28.5$, $P < .001$). One reason for this may be that distant affines (those with $r_{\text{Hughes}} < 0.125$) are less likely to be included in an individual's active social network. Thus, the set of acceptable affinal relationships might extend over a relatively narrower range than is the case for genetic kin and so might not include everyone in the extended network of one's in-laws.

One other point about affines is of interest. The data suggest that in terms of EC and contact frequency, affines of true average nominal relatedness $r_{\text{Hughes}} = 0.295$ are treated as though they were in fact related by $r \approx 0.25$ (fig. 4). Although these values do not differ significantly, the fact that the actual r_{Hughes} of affines is higher than that implied by ego's behavior toward them suggests that egos might not be quite as willing to invest in affines as heavily as their actual relatedness might demand. If this is so, then it implies that affinal relationships may be subject to a degree of discounting. It is conceivable that this reflects a real risk that marital relationships will break up in the future. If so, the difference between the genetic and r_{Hughes} values suggests that, in this population at least, there is a perceived risk of $(0.295-0.25)/0.25 \approx 0.20$ that a relationship might break up in the future. (An alternative explanation might be that this is an estimate of the degree of paternity uncertainty.) Divorce rates have been rising rapidly over the

Table 2. Linear mixed model for days to last contact by emotional closeness (EC) for genetic versus nongenetic, Hughes relatedness (r_{Hughes}), and all interactions

Term	F (df) or Wald Z	P
Intercept	1.3 (1, 72)	.000
EC	756.1 (1, 31)	.000
r_{Hughes}	143.1 (2, 200)	.000
Genetic [yes/no]	.0 (1, 166)	.969
EC $\times$ r_{Hughes}	108.2 (2, 309)	.000
EC $\times$ genetic	1.2 (1, 2,571)	.282
r_{Hughes} $\times$ genetic	.9 (2, 4,203)	.394
EC $\times$ r_{Hughes} $\times$ genetic	.6 (2, 5,157)	.530
Repeated measures	36.5	.000

Note. Values shown are either from the final fully reduced model or from when the term was removed during the modeling process.

past few decades in most developed countries, including Belgium, so that the relationship between perceived divorce risk and actual divorce risk may not necessarily be in alignment. As with most developed countries, the divorce rate in Belgium has been rising steadily over the past half century and was in excess of 55% in 2000 (Organisation for Economic Co-operation and Development 2001). However, if perceived divorce risk reflects past rather than current circumstances, then Belgium last had a divorce rate of ∼20% in 1978. This would suggest a cultural lag effect of around 30 years, a value that has been noted as being common in the context of cultural inheritance (Barrett, Dunbar, and Lycett 2002; Voland et al. 1997). A more robust test of this is clearly needed, but these data at least suggest that there is a prima facie case for the possibility that the closeness of affinal relationships is titrated by the experienced risk of future divorce.

Acknowledgments

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