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Familial and social transmission of suicidal behavior in older adults

Laura B. Kenneally¹, Anna Sz cs^{1,2}, Katalin Szántó¹, and Alexandre Y. Dombrovski¹

¹University of Pittsburgh School of Medicine, Department of Psychiatry, Pittsburgh, PA, United States

²University of Geneva, Department of Psychiatry, Geneva, Switzerland

Abstract

Background—Both biological and social mechanisms have been implicated in the transmission of suicidal behavior in younger and middle-aged adults. Yet, while suicide rates rise with age, it is not clear whether such mechanisms operate in late life. Thus, we looked for evidence of social and familial suicidal transmission in elderly with late- vs. early-onset suicidal behavior by examining exposure to suicidal behavior within biological relatives and broader social networks.

Method—Participants were 356 adults, aged 50 or older (mean: 67), divided into five groups: early-onset suicide attempters (first lifetime attempt before age 60), late-onset attempters, suicide ideators (without attempt history), depressed non-suicidal controls, and non-psychiatric controls. History of suicidal behavior in one's biological relatives and friends/unrelated kin was assessed via clinical interview, and group differences were examined via generalized linear mixed-effects models.

Results—There was a main effect of group ($\chi^2_4 = 18.38, p < 0.001$) such that familial or social exposure to suicidal behavior was more prevalent in early- than late-onset attempters. Late-onset attempters' exposure was similar to non-suicidal groups'. However, there was no significant group by relationship interaction, indicating that suicidal behavior was not significantly more prominent among the biological relatives among either attempter group.

Limitations—Participants' report of exposure is subject to awareness and recall biases.

Conclusion—Suicidal clustering in biological relatives and friends/unrelated kin is associated with early-, but not late-onset suicidal behavior in older adults. Suicidal transmission in older adults follows a pattern of familial and social clustering suggestive of social transmission.

Keywords

Suicide; Heritability; Social Learning; Geriatrics; Late-life Depression

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Please address correspondence to: Katalin Szántó, 100 North Bellefield Ave., Room 736, Pittsburgh, PA 15213, szantok@upmc.edu, 412-246-9601 (phone), 412-246-6030 (fax).

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Introduction

Suicidal behavior is known to run in families (Brent, DA et al., 2015; Brent and Mann, 2005; Brent and Melhem, 2008). Adoption, family, and twin studies show that offspring of suicide attempters have a 4–6 fold greater risk of attempting suicide (Brent, DA et al., 2002; Brent et al., 2004; Brodsky et al., 2008; Melhem et al., 2007). Some studies have documented familial transmission of suicidal behavior above and beyond the transmission of mood disorder (Goodwin et al., 2004; Kim et al., 2005; Mittendorfer-Rutz et al., 2008), and suicidal ideation (Fu et al., 2002; Statham et al., 1998). The mechanism by which this occurs, however, is still speculative. Adoption studies have found a higher rate of suicide in the biological relatives of the suicide adoptees than in the adoptive relatives (Schulsinger, 1979; Wender et al., 1986), and twin studies have found higher concordance rates in monozygotic than dizygotic twins (Roy and Segal, 2001). These findings indicate that, in young and mid-life populations, this effect may be at least in part genetic, and is potentially passed on through a shared personality phenotype of impulsive and aggressive traits (McGirr et al., 2009; McGirr and Turecki, 2007; Turecki, 2005). In addition to any genetic component, however, social and environmental factors, such as low socioeconomic status or unstable home-life, play a considerable role (Agerbo et al., 2002; Lorant et al., 2005). Research on suicide in social networks has demonstrated that suicidal behavior can be transmitted even outside of family environment, likely by imitation or social learning (de Leo and Heller, 2008; Maple et al., 2017). Risk of such social transmission increases when the suicide decedent was perceived as close (Lee et al., 2013; van de Venne et al., 2017), similar to oneself (Haw et al., 2013), or of high status (Fu and Yip, 2009). In addition, when the media romanticize a suicide, overlooking the destructive consequences, imitation is more likely (Pirkis et al., 2006).

Suicide rates rise as suicidal behavior becomes more serious and determined with advancing age (De Leo et al., 2001). In contrast, both familial (Brent, DA et al., 2002, p. 200) and social transmission have been found to decrease with age in young and mid-life samples (de Leo and Heller, 2008; van de Venne et al., 2017). Nonetheless, the transmission of suicidal behavior in late life remains largely understudied. Research examining familial transmission of suicidal behavior in late life is sparse and inconclusive (Nieto et al., 1992; Takahashi et al., 1995). Evidence for social learning as a transmission mechanism for late-life suicidal behavior is also mixed, as most studies demonstrate decreased impact over time, though some have found that exposure to a high-status, similarly aged person's suicide can increase risk of suicide in older adults (Stack, 1990).

However, none of the above studies considered the heterogeneity of suicidal behavior. In a subgroup of older individuals, suicidal behavior first emerges at a young age and persists through late life. These individuals often show the shared personality phenotype of impulsive and aggressive traits (McGirr et al., 2009; McGirr and Turecki, 2007; Turecki, 2005), and other features of borderline personality disorder. In contrast, in another subgroup of older individuals, suicidal behavior occurs for the first time in late-life. These individuals often have a different psychopathological and dispositional setting, with borderline personality disorder being much less common than in younger adults (Szücs et al., 2018), and cognitive deficits being more prominent (Szanto et al., 2018). This heterogeneity

introduces the question of whether subgroups of attempters would be equally susceptible to these modes of transmission. One study, comparing older adults who died by suicide with and without a family history, found that victims who also had a family member who died by suicide were more likely to have had previous episodes of suicidal behavior (Waern, 2005). This suggests greater familial transmission in older suicide victims who had an earlier onset of suicidality compared to those who become suicidal later in life. In addition, the evidence of familial transmission in young and mid-life samples further suggests that this form of transmission may be more prevalent in those with an earlier onset of suicidal behavior (McGirr et al., 2008).

The present study examined both familial and social transmission of suicidal behavior in an older-adult sample by looking at suicides or attempts in relatives (probands' biological first- and second-degree relatives), as well as among friends and unrelated kin (i.e., spouse). Familial transmission of suicidal behavior in attempters would be suggested by higher exposure from their biological relatives (compared to friends/unrelated kin) than in the control groups. Social transmission would be indicated by an overall increase in suicidal exposure in attempters vs. controls indiscriminately of the degree of relation, since one's relatives are also part of one's social environment (Figure 1, panel A). Based on the evidence supporting social transmission in older adults, we hypothesized that overall exposure to suicidal behavior would be higher in attempters compared to non-suicidal controls. Secondly, considering older attempters' heterogeneity, we hypothesized that transmission would follow a familial pattern in early- but not in late-onset suicidal behavior. We subdivided the attempter group accordingly (first attempt prior to age 60 vs. later).

Methods

Sample: probands

Participants were recruited between August 2004 and June 2017 from inpatient psychiatric units, outpatient clinics, and through community advertisements as part of an ongoing longitudinal study (Szanto et al., 2018). All study procedures were approved by the University of Pittsburgh Institutional Review Board, and all participants provided written informed consent. Family history of mental health and suicidal behavior was assessed in 362 non-demented depressed older-adults (aged 50 and older). Six participants who were adopted and had no information on their biological relatives were excluded from analyses. The remaining 356 participants were broken down into four groups: suicide attempters (n=131), suicide ideators (n=63), depressed non-suicidal participants (n=77) and psychiatrically healthy controls (n=85).

Suicide attempters were categorized as such if they had a history of self-inflicted injury enacted with intent to die at any point during their life, and had either current suicidal ideation (i.e. with a plan), or suicidal behavior within the last month. Suicide attempters were further broken down into early-onset (first attempt before age 60; n=63) and late-onset (first attempt at age 60 or later; n=68), based on a median split. Attempters were not required to have made a recent attempt, but were required to be experiencing a suicidal crisis at the time of consent. Suicide Ideators had no history of suicidal behavior, but had seriously contemplated suicide with a plan within one month of consent. Depressed non-suicidal

participants had no lifetime history of suicidal ideation or attempt. Individuals with passive death wish or transient or ambiguous suicidal ideas were excluded from both the ideator and the depressed non-suicidal group.

All depressed groups (depressed non-suicidal controls and the three suicidal groups) scored 14 or higher on the 17-item Hamilton Rating Scale for Depression (HRSD-17)(Hamilton, 1960) at study entry. Healthy controls had no lifetime history of psychiatric disorders as determined by the Structured Clinical Interview for the DSM-IV (SCID-I)(First et al., 1995). Attempt and ideation history was assessed using patient report, available medical records, and collateral information from family and treatment teams. Whenever possible, for all study groups, corroboration from a treatment provider or family member of the participant was obtained. Significant discrepancy between sources led to exclusion from the study. Other exclusion criteria included history of mania, psychotic disorder, dementia (existing clinical diagnosis, or score<22 on the Mini-Mental State Examination), neurological disorder, or electroconvulsive therapy in the six months prior to study entry.

Measures

All probands underwent thorough clinical characterization (described in Table 1). Lifetime history of psychopathology and stressors, Axis I diagnosis, age at first attempt, and age at first onset of psychopathology was measured using the SCID-I. Medical seriousness of attempt and suicidal intent were collected for all attempts, assessed using medical records and patient report, and scored using respectively the Beck Lethality Scale and the Beck's Suicidal Intent Scale (Beck et al., 1975, 1974). Suicidal Ideation was assessed using Beck's Scale for Suicidal Ideation (Beck et al., 1979). Level of depression was measured by the HRSD-17 (Hamilton, 1960).

Exposure to suicidal behavior was assessed via semi-structured interview. Probands were asked separately about presence of suicidal behavior or Axis I pathology in a list of individuals (mother, father, children, siblings, grandparents, half-siblings, aunts, uncles, cousins, step-relatives, spouse, in-laws, friends, other). Exposure was coded as occurring in a "relative" when it was recorded in a biological (first- or second-degree) relative. All other exposures were coded as occurring in "friends and unrelated kin" (Table 1).

Statistical Analysis

All analyses were performed in R, version 3.3.2. We employed generalized linear mixed-effects models (binary logistic; *lme4* package, *glm* function), including the subject-wise intercept (representing the likelihood of reporting any exposure to suicidal behavior) as a random effect. Tukey's method was used for post-hoc pairwise comparisons. Exposure to suicidal behavior was the binary dependent variable. Within-subject independent variables included exposure characteristics: "relationship" (1st degree relative, 2nd degree relative, or friend/unrelated kin) and "severity" (suicide attempt versus death by suicide; Figure 1, panel A). Proband's age was also entered in the main model in order to account for the significant age difference between the early- and late-onset attempter groups (Table 1). Adding age to the model did not create effects that were previously insignificant.

Study group ('group') was the between-subjects predictor of interest. To examine social transmission, we looked for evidence of suicidal behavior in both biological relatives and friends of suicide attempters vs. the comparison groups (a main effect of group). To examine whether familial transmission specifically contributed to suicidal behavior in a subgroup of attempters (hypothesized in early-onset), we tested study groups for an overrepresentation of suicidal behavior among first- and second-degree relatives compared to friends and unrelated kin. This would be supported by a Group*Relationship interaction, with increased exposures specifically in one's relatives compared to friends and unrelated kin (Figure 1, panel A). As a sensitivity analysis, we tested two additional models. Model 2 contained proband's socio-demographic characteristics (Table 3, Model 2). Model 3 additionally co-varied for measures of proband's comorbid psychopathology (Table 3, Model 3). Finally, to replicate earlier findings of familial exposure in studies that did not additionally assess for exposure in non-relatives (Egeland and Sussex, 1985; Foster et al., 1999; Powell et al., 2000; Tsai et al., 2002; Tsuang and Simpson, 1985) we tested our main model in a dataset that omitted exposures to suicidal behavior among friends/unrelated kin (supplementary Table 1).

Results

Sample characteristics

Participant characteristics are described in Table 2. As expected, early-onset attempters and suicide ideators had an earlier onset of depression and were younger than late-onset attempters and control groups. While all three suicidal groups were more severely depressed (HRSD-17) than non-suicidal depressed controls, only early-onset attempters and ideators, scored higher than the depressed controls on all measures of psychopathology.

Exposure to suicidal behavior

Raw event counts (number and percentages) for suicide attempts and death by suicide in probands' familial and social environment by relationship can be found in Supplemental Table 1.

Age Cutoff

An age cutoff of 60, as determined by a median split, was used to discriminate early- and late-onset attempt. To investigate the robustness of our findings to the specific age cutoff, we plotted LOESS-smoothed probability of social or familial exposure to suicidal behavior by age at first attempt, and found that this relationship was monotonic and continuous (see supplementary Figure 2), reassuring us that the findings did not depend on an arbitrary cutoff.

Clustering of Suicidal Behavior among Relatives and Friends and unrelated kin of Suicide Attempters

In our principal model, we examined three interactions: group by relation, severity by relation, and age by severity (Table 3; Model 1). Group differences are displayed in Figure 1, panel B. There was a main effect of group ($\chi^2_4 = 18.38, p < 0.001$), with pairwise comparisons demonstrating that early-onset attempters had a higher likelihood of exposure to suicidal behavior than late-onset attempters, depressed non-suicidal controls, and healthy

controls. Late-onset attempters did not differ significantly from any other group in terms of their likelihood of exposure. Ideators were more likely to have had exposure to suicide than healthy controls, but did not significantly differ from the other depressed groups. These effects supported overrepresentation of suicidal behavior in social networks of early-onset attempters and ideators vs. the comparison groups.

The group by relationship interaction was not significant, failing to support an overrepresentation of suicidal behavior specifically within biological relatives (rather than any social contacts). Likelihood of exposure by group and relationship is shown in Figure 1, Panel C. There was a significant relationship by severity interaction, demonstrating a higher likelihood of exposure to suicide than attempt in one's non-relatives. There was also an age by severity interaction, such that individuals below 60 years of age reported similar exposure to attempts and suicides, whereas older age groups were more likely to report exposure to death by suicide (vs. attempt).

Sensitivity analyses confirmed that these results were robust to covarying for proband demographic characteristics and psychopathology, including age, race, sex, education, marital status, lifetime anxiety disorder, and lifetime substance use disorder. Age was ultimately retained, while the addition of the remaining covariates did not substantially improve model fit (Table 2).

Restricting analysis to familial transmission

Given that we did not find clustering of exposures within families vs. broader social networks, we aimed to replicate earlier findings of studies (Egeland and Susse, 1985; Foster et al., 1999; Powell et al., 2000; Tsai et al., 2002; Tsuang and Simpson, 1985) that examined familial exposures exclusively, and verify that the pattern of exposure was similar. We expected that an analysis limited to exposures in relatives (i.e. with the outcome variable being exposure to behavior in 1st and 2nd degree biological relatives) would find group differences that paralleled those in our main analysis. Indeed, this restricted analysis revealed a main effect of group similar to our principal analysis (supplementary material, Figure s1): early-onset attempters were significantly more likely to have had a family history of exposure than depressed and healthy controls, while ideators and late-onset attempters were not more likely to have had exposures in their families than any of the other groups.

Discussion

Our primary finding suggests the influence of social transmission of suicidal behavior in a subgroup of older adults, supporting our hypothesis that older suicide attempters are heterogeneous. While early-onset attempters were significantly more likely to have been exposed to suicidal behavior, contrary to what we expected, these exposures were not significantly more common within their biological family members. In addition, the lower prevalence of any exposure found in late-onset (vs. early-onset) attempters suggests that the importance of social and familial transmission declines with advancing age. Therefore, when present, vulnerability to exposure from any degree of relation likely stems from an earlier age, and persists into late life.

These results provide evidence for social, but not necessarily biological (i.e. genetic) transmission of suicidal behavior in an older adult sample. Given that the model assessing exclusively familial exposure showed a similar pattern of exposures by group as the principal model, it may be the case that familial exposure serves as a proxy for exposure anywhere in elderly attempters' social environment. It could also be that, a present, but relatively smaller genetic component was obscured by the larger social transmission effects. As gene expression becomes more heterogeneous with aging (Somel et al., 2006), genetic effects likely require greater power to detect in the elderly. Survival bias may eliminate the most biologically burdened suicidal individuals, which, in combination with gradually increasing chance of social exposure throughout life, could result in comparatively lower levels of exposure in biological relatives. Alternatively, heritable determinants of suicidal behavior may either be different, or manifest differently in older and younger adults. In line with antagonistic pleiotropy, it may be that some genes linked to adaptive phenotypes at a young age have unanticipated maladaptive consequences during aging (Szücs et al., under review). Additionally, Richard-Devantoy and colleagues proposed different vulnerability pathways (2016). Whereas early-onset individuals have an identifiable vulnerability from a young age, some older adults may have inherited vulnerabilities that exacerbate throughout the life-course (increasing lifetime vulnerability), or vulnerabilities with a late-life onset, like disposition for vascular disease (pathological aging). In these latter cases, familial clustering is likely to be obscured by low penetrance and survival biases. There are multiple mechanisms that operate together both in familial and social transmission of suicidal behavior. The shared genetic component includes liability to impulsive-aggression, personality traits, substance abuse, mental disorders, and neurodevelopmental vulnerabilities. In turn, social transmission of suicidal behavior is primarily mediated by social learning, but may also be moderated by shared biological susceptibility. These interdependent effects make it difficult to parse biology from shared environment (Baldessarini and Hennen, 2004).

What are then the possible mechanisms of social transmission in those with early-onset suicidal behavior, and why is this different from those with late-onset? Suicidal behavior in adolescence has been linked to family history of suicide (Brent et al., 1996), childhood trauma (Brent, DA et al., 2002), and subsequent maladaptive learning during personality development (Jacobs, 1971; Leonard, 1967). Early-life exposure effects are likely mediated by modeling of suicidal behavior as well as broader social learning of maladaptive responses to distress. Though we do not know the exact age of exposure of our early onset attempter participants, it is notable that in some cases the effects of early life suicide exposures may persist into late life.

In addition, certain social networks (e.g. schools) can facilitate the rapid diffusion of self-harm behaviors. Older adults are less conforming to peer influences than adolescents who are more prone to imitation effects (suicide suggestions; Mueller et al., 2015). Thus, it is not a surprise that adolescents are two to four times more likely to experience a suicide cluster than adults (Gould, 2001). While social theories emphasize that exposure to suicide undermines natural deterrents to suicidal behavior, we do not know how modeling of suicide interacts with other risk factors. People with early-onset depression and suicidal behavior are often impaired in multiple domains, with a greater burden of psychopathology and

personality pathology in particular (Brodaty et al., 2001; Szücs et al., 2018) and a greater likelihood of multiple attempts (Conwell et al., 1998; De Leo et al., 2001). A study by Zisook and colleagues linked the earlier age of onset with greater social/occupational impairment, medical and psychiatric comorbidity, poorer quality of life, a negative view of life and the self, lifetime depressive episodes/suicide attempts, greater symptom (and ideation) severity, and a lower likelihood of being married (Zisook et al., 2007).

Many of the aforementioned characteristics that may co-occur with social exposure to suicide are less common in late-onset suicidal behavior. Our finding that social exposure is not a primary risk factor in the late-onset attempters contributes to a growing body of evidence suggesting that the mechanisms responsible for suicidal behavior in late life are different than in younger populations. The first incidence of suicidal behavior in late-onset attempters (mean age of onset of first attempt) was 70 compared to 41 in the early-onset group. Late-onset attempters are often relatively high functioning until a first onset of depression and suicidality in late life. A qualitative psychological autopsy study of older adults described a sample of individuals who had stable relationships with coworkers and family, worked hard throughout their lives, and overcame financial adversity, but were generally stubborn (Kjølseth et al., 2010). This is congruent with literature suggesting that there may be cognitive (Dombrovski et al., 2011; Szanto et al., 2018), or more nuanced personality factors (Alessi et al., 2018; Szücs et al., 2018) that interact with age-related changes, ultimately leading to suicidality in formerly high-functioning individuals (Szücs et al., 2018). It may be the case that those with late-onset suicidal behavior are less impacted by social exposure due to less personality pathology, and are more tolerant of minor stressors. In this way, they may need more co-occurrent stress to be motivated to imitate the suicidal behavior when exposed.

Age was related to reported exposure in our study, with older individuals reporting less exposure to suicide attempts relative to completed suicides. It is possible that older individuals were more likely to remember completed suicides, rather than attempts, over time. There may also be a cohort effect, as suicidal behavior was more often stigmatized in the past and less likely to be discussed, whether within or outside of one's family.

Strengths and Limitations

To the extent of our knowledge, this study is the first to investigate both familial and social exposure to suicide in a relatively large elderly sample with multiple comparison groups. This expands upon our understanding of late-life suicidal behavior, and its differences/similarities with suicidal behavior earlier in life. However, the present study is also subject to several limitations. First, we are relying on participants' reports of suicidal exposure, which is subject to awareness and recall biases. Even though including age in our model should have controlled for additional age-dependent recall biases, late-onset attempters may have been less likely to report exposures overall. It is possible that they reported less exposure to suicidal behavior because they were less attentive to these events in their environment before struggling with the thoughts themselves. Also, our cutoff of 60 for subdividing early- vs late-onset suicide attempts is quite high, possibly creating a biologically heterogeneous group of early-onset attempters. However, we show that the

relationship between the probability of familial or social exposure to suicidal behavior and age at first attempt is continuous and monotonic (see supplementary Figure 2). Not having dates associated with the reported suicidal events, we additionally cannot tell when the exposures occurred during life. Even though we excluded adopted subjects from the analysis, we did not have the means to check whether some of the reported siblings/children were themselves adopted. In addition, assessing the impact of exposure in an older sample is inherently subject to less certainty than in younger populations, as some risk factors for suicide (depression, substance abuse) shape whom the individual befriends over the lifespan (assortative relationships), and these individuals may also share similar suicide risk factors (assortative susceptibility) (Schaefer et al., 2011). Moreover, more violent or medically serious suicidal acts are more likely to be associated with a family history of suicide (Giner et al., 2014), which may contribute to survival bias. Finally, though our study intentionally limited the sample to non-psychotic, unipolar depression, this does limit the degree to which these findings are applicable to suicidal behavior in other samples.

Conclusion

The study confirms the importance of considering the familial and social exposure to suicide even in late life, particularly when the first suicide attempt occurred at a young age. Existing studies have not considered the heterogeneity of late-life suicidal behavior, which may contribute to the lack of consistency in the literature regarding the transmission of suicidal behavior in older adults. The lack of evidence for social transmission of late-onset suicidal behavior underscores the need to describe other mechanisms that underlie suicidal behavior in this high-risk group.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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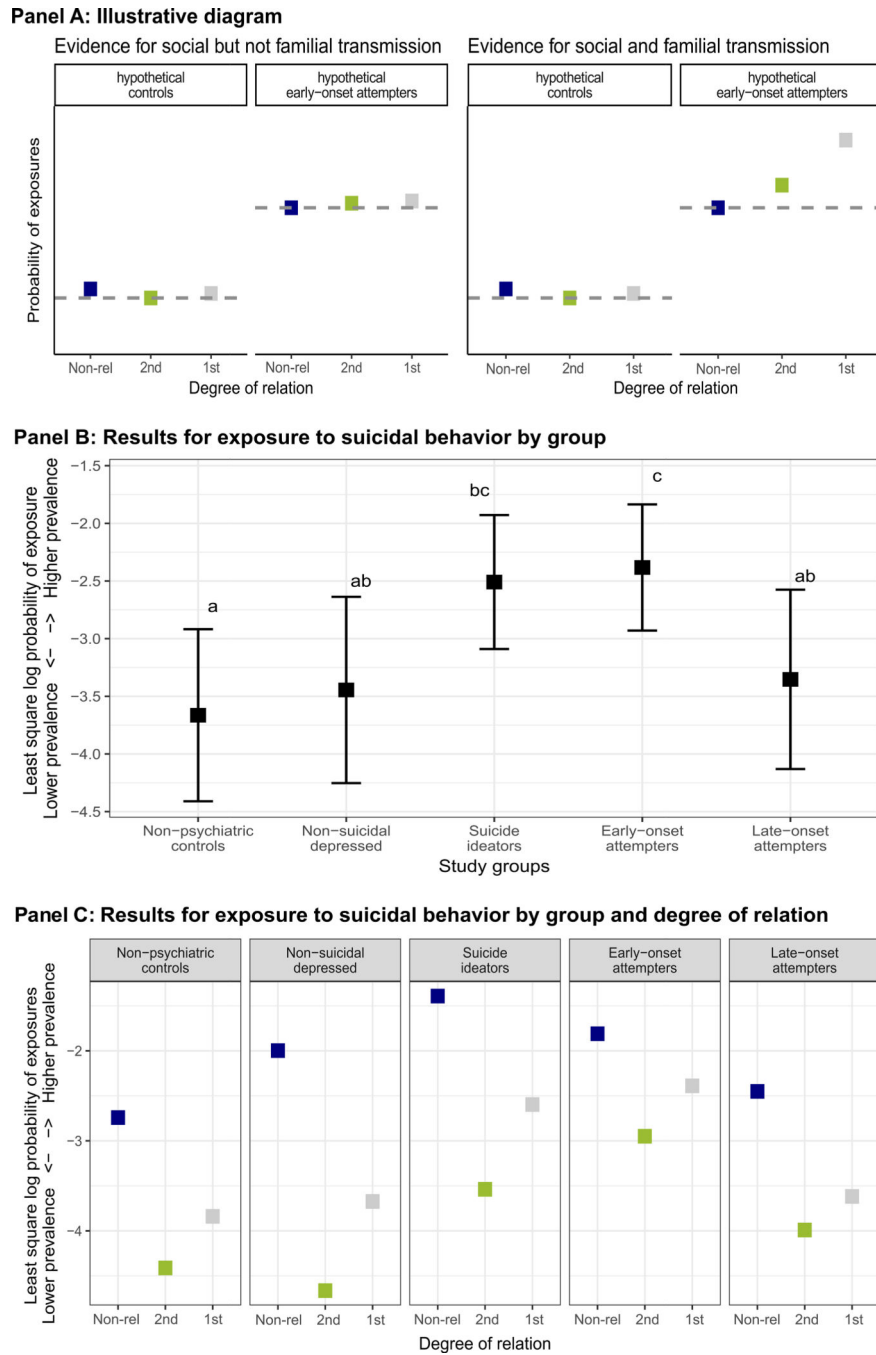


Figure 1.
Figure 1A. Schematic representation of evidence for social and familial transmission as it would appear in our model. Dashed gray line represents the intercept. Group differences in social transmission would be indicated by the difference in intercept. Familial transmission would be indicated by relatively more exposures in family (gray data points) of the hypothetical early-onset attempters (vs. controls) compared to friends and unrelated kin (black data point).

Figure 1B. Exposure to suicidal behavior likelihood in study groups. Boxes indicate estimated marginal mean logit probability. Error bars indicate 95% confidence interval for the estimated marginal mean. Means sharing a letter are not significantly different (Tukey-adjusted comparisons).

Figure 1C. Patterns of exposure, by group and relation. The spread of exposures between relatives and non-relatives did not differ sufficiently enough between groups to confer significant familial loading in early-onset attempters.

Table 1.

Definitions of exposure and transmission types

Exposure categories (measured in the study)	
Relatives	First- or second-degree biological relation to the proband
Friends and unrelated kin	Friends or non-blood relatives (spouse, adopted relatives, in-laws)
Transmission types (inferred from measured exposure)	
Familial	More exposures within biological relatives (compared to friends and unrelated kin) of attempters
Social	More exposures altogether (biological relatives and friends/unrelated kin) in attempters (compared to controls)

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Group characteristics All categorical variable comparisons were computed using Chi Square tests, and all continuous variables were computed using ANOVA unless otherwise noted.

Table 2.

	Missingness	Non-psychiatric controls N=85	Non-suicidal depressed N=79	Suicide ideators N=63	Early-onset attempters N=65	Late-onset attempters N=68	p-value	Post-hoc comparisons
Demographics								
Age	-	69.1 (9.2)	68.8 (8.9)	63.9 (8.2)	61.0 (7.2)	71.1 (8.4)	<0.001	I, EO<HC, D, LO
Gender (female)	-	48 (56.5%)	46 (58.2%)	28 (43.1%)	37 (56.9%)	31 (45.6%)	0.222	-
Race (African-American)	-	11 (12.9%)	11 (13.9%)	9 (13.8%)	10 (15.4%)	7 (10.3%)	0.841	-
Education	-	15.3 (2.9)	14.5 (2.5)	14.4 (3.0)	13.8 (2.8)	13.4 (3.2)	<0.001	EO, LO<HC
Marital Status (not single)	-	50 (58.8%)	38 (48.1%)	22 (33.8%)	25 (38.5%)	21 (30.9%)	.004	I, LO<HC
HRSD-17 ^a	.002	NA	16.7 (4.5)	20.2 (5.1)	20.4 (5.9)	19.7 (5.9)	<0.001	D<I, EO, LO
Substance (lifetime)	-	NA	16 (20.3%)	29 (44.6%)	38 (58.5%)	22 (32.4%)	<0.001	D<I, EO LO<EO
Anxiety (lifetime)	-	NA	30 (38.0%)	40 (61.5%)	40 (61.5%)	31 (45.6%)	0.008	D<I, EO
Age of depression onset	.05	NA	53.9 (19.5)	42.3 (21.0)	36.2 (17.1)	53.0 (22.5)	<0.001	I, EO<DC, LO
Attempt characteristics								
Total number of attempts	-	NA	NA	NA	2.9 (2.8)	1.4 (0.8)	<0.001	LO<EO
Maximum attempt lethality	-	NA	NA	NA	3.4 (2.2)	3.9 (2.1)	0.123	-
Intent scale: planning	-	NA	NA	NA	8.0 (3.0)	8.0 (3.3)	0.978	-
Age at first attempt	-	NA	NA	NA	41.0 (15.3)	70.3(8.7)	<0.001	EO<LO
Family history								
Affective disorder in a first-degree relative	-	12 (14.1%)	23 (29.1%)	14 (21.5%)	25 (38.5%)	17 (25.0%)	0.013	HC<EO
Substance use in a first- degree relative	-	9 (10.6%)	8 (10.1%)	13 (20.0%)	14 (21.5%)	11 (16.2%)	0.183	-
Affective disorder in spouse ^b	-	3 (3.5%)	7 (8.9%)	5 (7.7%)	3 (4.6%)	4 (5.9%)	0.626	-
Substance misuse in spouse ^b	-	4 (4.7%)	1 (1.3%)	0 (0.0%)	2 (3.1%)	1 (1.5%)	0.375	-

HC= Non-psychiatric control, D= Depressed non-suicidal control, I= Ideator, EO= Early-onset attempter, LO= Late-onset attempter.

^a17-item Hamilton, without the suicide item

^bCompared using Fisher's exact test

Table 3

Regression models predicting exposure to suicidal behavior. Model 1 is the principal model. Model 2 depicts a sensitivity analysis including demographic covariates (race, education, sex, marital status), and Model 3 depicts a sensitivity analysis additionally including psychopathological covariates (lifetime history of anxiety or substance use disorder).

	<i>Dependent variable:</i>		
	Exposure to suicidal behavior		
	(1)	(2)	(3)
Proband study group			
Depressed Controls vs. Healthy Controls	0.68 * (0.34)	0.75 * (0.34)	0.59 (0.35)
Ideators vs. HC	1.28 *** (0.33)	1.33 *** (0.34)	1.09 ** (0.36)
Early-onset Attempters vs. HC	0.81 * (0.34)	0.94 ** (0.35)	0.67 (0.38)
Late-onset Attempters vs. HC	0.21 (0.38)	0.26 (0.39)	0.04 (0.41)
Relationship to proband			
Relationship: First-degree relative (vs. non-relative)	-0.18 (0.58)	-0.17 (0.58)	-0.16 (0.58)
Relationship: Second-degree relative	-1.12 (0.72)	-1.12 (0.72)	-1.11 (0.72)
Severity of exposure			
Exposure severity (Suicide vs. attempt)	1.83 *** (0.26)	1.85 *** (0.26)	1.86 *** (0.26)
Clustering in relatives vs. non-relatives of suicide attempters			
Depressed * First-degree relative	-0.58 (0.73)	-0.59 (0.73)	-0.59 (0.73)
Ideator * First-degree relative	-0.10 (0.63)	-0.11 (0.63)	-0.13 (0.64)
Early-onset attempters * First-degree relative	0.52 (0.62)	0.51 (0.63)	0.50 (0.63)
Late-onset attempters * First-degree relative	-0.07 (0.78)	-0.07 (0.78)	-0.09 (0.78)
Depressed * Second-degree relative	-0.99 (0.98)	-1.00 (0.98)	-1.01 (0.98)
Ideator * Second-degree relative	-0.46 (0.79)	-0.48 (0.79)	-0.50 (0.79)
EoAttempter * Second-degree relative	0.54 (0.75)	0.53 (0.75)	0.52 (0.75)
LoAttempter * Second-degree relative	0.13 (0.91)	0.13 (0.91)	0.11 (0.91)
Severity of exposure by relationship			
First-degree relative * Suicide Severity	-1.84 *** (0.39)	-1.86 *** (0.40)	-1.86 *** (0.40)
Second-degree relative * Suicide Severity	-1.09 * (0.49)	-1.10 * (0.49)	-1.11 * (0.49)
Proband characteristics			
Severity * Age	0.55 ** (0.21)	0.55 ** (0.21)	0.56 ** (0.21)
Age of proband	-0.77 *** (0.18)	-0.75 *** (0.18)	-0.72 *** (0.18)
Race		-0.61 * (0.27)	-0.61 * (0.27)
Education		0.04 (0.03)	0.04 (0.03)
Sex		0.24 (0.16)	0.19 (0.17)
Marital Status		0.06 (0.17)	0.04 (0.17)
Anxiety Disorder			0.28 (0.19)
Substance use disorder			0.21 (0.19)

<i>Dependent variable:</i>			
Exposure to suicidal behavior			
	(1)	(2)	(3)
Constant	-3.35*** (0.33)	-4.07*** (0.57)	-4.11*** (0.58)
Observations	2,136	2,136	2,136
Log Likelihood	-546.94	-540.56	-538.52
Akaike Inf. Crit.	1,133.89	1,129.12	1,129.04

* *Note:* p<0.05

** p<0.01

*** p<0.001

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