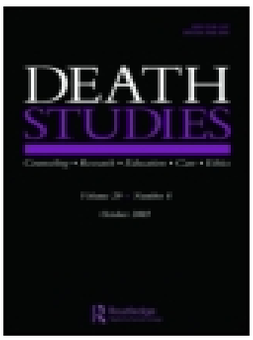

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A linguistic study of Chinese Weibo users who lost their only child

Mingming Liu[a,b], Tianli Liu[c], Xinyu Wang[d], Nan Zhao[a], Jia Xue[e*], and Tingshao Zhu[a]

[a]Institute of Psychology, Chinese Academy of Sciences, Beijing, China; [b]Department of Psychology, University of Chinese Academy of Sciences, Beijing, China; [c]Institute of Population Research, Peking University, Beijing, China; [d]College of Biochemical Engineering, Beijing Union University, Beijing, China; [e]School of Social Policy & Practice, University of Pennsylvania, Philadelphia, Pennsylvania, USA

ABSTRACT

The loss of an only child is one of the most painful life events and creates tremendous change in its parents' lives. Analyzing parents' online language use may help to better understand their loss, especially their psychological process. This study compared the online word use of 228 lost-only-child (LOC) parents to that of their peers. We also tracked the change in word use for a subset of these parents ($n = 36$) quarterly during the first 2 years following their bereavement. The implications of the word use of Chinese LOC parents for mood, parent–child bond, and lifestyle are then discussed.

The death of a child is one of the most painful events that a parent can experience. This pain, which results in changes to one's psychological status, comes most severely in the first few months after bereavement and significantly declines over time (Parkes, 1970; Ringdal, Jordhøy, Ringdal, & Kaasa, 2001). However, it is still unknown how the psychological status of lost-only-child (LOC) parents in China changes during the initial months after the bereavement; this may hinder providing LOC parents with professional and timely support.

Since the late 1970s, when the "one-child" policy was implemented nationwide, one-child families have been pervasive in China. As their number has increased, so has the number of LOC families. There were over one million of these in 2012, and 76,000 families are estimated to join this group each subsequent year (Wu & Dang, 2013). Unlike other bereaved parents who make their own choice to have only one child, Chinese parents typically do not have a second child not out of choice but because of policy. With a culture of "the worst unfilially thing is to have no son," Chinese parents who have no small passion for parenting give all their spared energy, money, and emotions to their one and only child. Some new phrases, such as "little-emperor syndrome" and "a generation spoiled," have been created to describe only children and their strong connection with their parents. The influence of bereavement on Chinese LOC parents, therefore, appears to be a unique issue to explore.

The break of the firm and precious parent–child ties bring tremendous harm to LOC parents. Some studies have revealed that Chinese LOC parents have a higher risk of psychiatric disorders (Li, Laursen, Precht, Olsen, & Mortensen, 2005), such as complicated grief (Xiu et al., 2016), depression (Wang, Pan, & Liu, 2015), and posttraumatic stress (Pan, Liu, Li, & Kwok, 2016; Zhang et al., 2016). Besides, the LOC parents were considered to suffer social fractures, which refer to a tremendous change in their previous living style (Fang, 2013). As Chinese parents devote all their efforts to their only child, the breakup of the parent–child relationship leads to serious adaptation problems. Such cross-sectional studies, however, since they did not account for the critical role played by the passage of time, cannot describe the gradual development of an individual's reactions after traumatic events (Manne, 2002).

Many, basing their research on western samples, have found the outcome of bereavement to be a dynamic process. For example, Meert et al. (2011) found that the grief of bereaved parents decreased over 2 years. Stockton, Joseph, and Hunt (2014) reported positive posttraumatic growth after conducting an internet-based study over eight weeks.

CONTACT Tingshao Zhu tszhu@psych.ac.cn Institute of Psychology, Chinese Academy of Sciences, Room 810, Hexie Buiding, 16 Lincui Road, Chaoyang District, Beijing 100101, China.
*Faculty of Social Work, University of Toronto, Toronto, Ontario, Canada.
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Tracking the trajectory of the psychological process of LOC parents over time, especially shortly after the bereavement, can offer a bounty of information about their adaptive process in the early stages of loss, which is helpful for offering early psychological intervention.

General research methods are currently unable to record the dynamic psychological process closely after an event. It is difficult for traditional questionnaire-based studies (e.g., Keesee, Currier, & Neimeyer, 2008) or structured interviews (D'Agostino, Berlin-Romalis, Jovcevska, & Barrera, 2008; Meert, Briller, Myers Schim, Thurston, & Kabel, 2009) to repeatedly measure psychological variables in a short time, or to recruit participants that have just experienced a traumatic event. On the one hand, the participants may become bored with the repeated questions, which may lead to inaccurate results. On the other hand, since the LOC parents are rare and sometimes withdrawn, it is difficult to obtain a sufficiently large sample for longitudinal studies. In some bereavement studies, the response rate did not exceed 10% (Meert et al., 2011).

Text analysis is an emerging method for understanding the dynamic psychological process after bereavement (Arntz, Hawke, Bamelis, Spinhoven, & Molendijk, 2012; Consedine, Krivoshekova, & Magai, 2012). It is a retrospective approach that can analyze a subject's psychological process at the time that the text was written. The subject's manner of expression changes over time along with her feelings. The results of text analysis thus change accordingly. We can, therefore, monitor and understand LOC parents' dynamic psychological process for as long as we have updates after the bereavement. The popularity of online social networks (OSNs) means that a large amount of date-marked text data can be collected from users of social media. Many LOC parents actively make friends and express their feelings. There is sufficient date-marked data on OSNs to make it possible to track the dynamic psychological process after bereavement.

The Linguistic inquiry and word count (LIWC; Pennebaker, Booth, & Francis, 2007) is the most-used text analysis tool for computing the relative percentage of different word categories, many of which have been shown to have associations with psychological processes. Individuals who inhibit emotional expressions are more vulnerable to health problems (Berry & Pennebaker, 1993). Manne (2002) found that a more frequent employment of words relating to death and metaphysical statements from the dimension of personal concerns indicate a higher level of psychological distress. It is believed that written expression reveals important information about one's present inner thoughts and feelings (Pennebaker & King, 1999; Tausczik & Pennebaker, 2010).

Among the dozens of word categories of LIWC, we selected three aspects that can best reflect the psychological process after bereavement: mood, parent–child bond, and lifestyle. The reasons for this selection are now explained. First of all, prior studies found that after bereavement, the use of mood words and mental health problems were strongly associated with each other (Ruthven, 2012). In their writing samples, bereaved parents were found to use more negative emotional words and fewer positive emotional words compared with non-bereaved parents (Baddeley & Singer, 2008; Diminich & Bonanno, 2014). Boals and Klein (2005) found that people who experienced negative life events tended to use more negative emotional words, and the use of more negative emotional words predicted greater mental health problems in the future. We thus reorganized positive emotion words, negative emotion words (and its sub-category, sad words), and death words as indexes of the mood words. Secondly, the strength of continuing parent–child bonds can be an index to adaptation. Klass and Walter (2001) claimed that the parent–child relationship can be maintained after the bereavement in several ways, including writing to the deceased. Getty et al. (2011) measured the strength of the parent–child connection on Facebook, by counting the frequency with which bereaved parents wrote about the relationship. Although a proper continuing connection can be psychologically healthy, an overly strong bond with too many external expressions will lead to indulgence in grief, and a corresponding resistance towards starting a new life (Davies, 2004). Thirdly, words that describe daily behaviors can reflect the real impact of loss on the LOC parents' lifestyles. Four dimensions were considered in this study: work, achievement, leisure, and religion.

In this paper, we propose to identify psychological development patterns among LOC parents via text analysis of their microblogs during the first 2 years after bereavement. The current study was conducted on Sina Weibo, a leading Chinese microblogging site. The most popular form of social media in China, Sina Weibo has more than 100 million active users and can produce 117 million microblogs per day (eMarketer, 2019). We first compared the overall word use between LOC parents and their correspondingly matched control group. Then, as only few users in our sample mentioned the time their only child died, we used a sub-sample to explore the LOC

Table 1. The number of LOC parents that met each criterion and examples.

	Number of LOC users	Example
The username contains "lost-only-child" ("失独")	5	"lost-only-child mother", "The voice of the lost-only-child parent"
The personal profile contains revealed "lost-only-child"	23	"The pain of bereavement is so hard that we should get together to get over it" ("失独之痛, 抱团取暖")、"The private prosecution of the lost-only-child parent" ("一位失独家长的自诉")
States lost-only-child in posts	190	"Although it was Mothers' Day yesterday, mom can never heard your greetings. I will miss you forever." ("昨天虽然是母亲节, 但是母亲再也没等到儿子你的问候, 儿子妈妈永远怀念你")、"I am a lost-only-child mother in Gansu. My son was dead and I was sick all the time …" ("我是一位甘肃平凉失独母亲, 儿去心空, 身体多疾 … …")
Join the lost-only-child group and admit the identity	10	"Pray that the government will legislate to keep us lost-only-child parents alive" ("祈求政府立法, 让我们 … … 这些无儿无女的苦命人能活下去")、"Thank you for the help and understand from the lost-only-child community" ("感谢同命人的帮助和理解")

parents' dynamic pattern of mood, parent–child bond, and lifestyle after the loss of the only child. As post-traumatic growth was observed in Western bereavement samples (Stockton et al., 2014), we assumed that the LOC parents would show similar positive changes. Thus, we hypothesized that the LOC parents show more positive emotions and fewer negative emotions over time, and gradually loosen their connections with the deceased children. We did not make any prior predictions regarding lifestyles.

Method

Case selection

The current study employed online samples to investigate changes in the character of the language used by parents in China who have lost an only child. Sample 1 was used to compare the overall word use between LOC parents and their control group. Sample 2 was used to track the change in LOC parents' word use after they lost their child. We utilized two samples because the time after bereavement is important for capturing word use. Given that only few users in our sample mentioned the time their only child died, we only tracked users in Sample 2 who mentioned the time of bereavement and frequently used Weibo in the 2 years afterward. Privacy protection was strictly conducted during the study process, in line with the ethical principles listed by Kosinski, Matz, Gosling, Popov, and Stillwell (2015), and the research protocol was approved in advance by the Ethics Committee of the Institute of Psychology, Chinese Academy of Sciences (approved number: H15009).

Sample 1

Sample 1 comprised of 228 LOC parents. We utilized a snowball sampling method to recruit LOC parents on Sina Weibo. First, we searched for the term "lost-only-child" ("失独") in usernames. In this step, we found 15 Weibo users whose username contained this bereavement information. Secondly, to find more, we checked all the friends of the 15 LOC users as well as users who were in the same Weibo group as the LOC parents. Lastly, we repeated this process to examine the friends and group members of the LOC users found in Step 2. In all, we found 238 LOC users, none of whom were parents of the same child. Among the 238 LOC users, 10 users were removed because they had fewer than 30 Weibo posts, leaving a total of 228 LOC users in Sample 1.

In this study, we used four criteria to determine if a user was a LOC parent: (1) users who used "lost-only-child" in their usernames; (2) users who described themselves as LOC parents in their profile; (3) users who claimed that they were LOC parents in their posts; (4) users who revealed that they were LOC parents by joining bereavement groups and actively interacting with group members. Users that met any of the above four criteria were considered to be candidates for LOC parents. Two researchers then read all of the users' profile information and posts individually and made a judgment together. The date of the bereavement was identified at that same time. The number of users that met each criterion and some examples are given in Table 1.

We also recruited 228 ordinary users who matched the profile information of LOC users. Although all of the users provided their gender and place of residence, only 69 of the 228 final LOC parents disclosed their age. Since the LOC parents were all in their later years, while the majority of Weibo users is born after 1990 (China Internet Watch, 2014), we selected the age range of the control group to match the 69 users who had provided their age. Thus, the age of the control group ranged from 40–65 years old. In addition, the gender and place of residence of the comparison users were matched to that of the LOC parents one by one. The final comparison contained 226 Weibo users, as two of the LOC parents could not be matched.

Sample 2

Sample 2 was a subset of Sample 1 that contained 36 LOC parents and 36 ordinary users. A total of 63 LOC parents mentioned their bereavement date in their Weibo profile. Among them, 36 LOC users frequently recorded their thoughts and feelings on Weibo in the 2 years afterward. All of these 36 LOC parents made more than 30 posts in most quarters of the year; exceptions were no more than two seasons long. We also recruited a control group according to their age and gender. Given that the sample size was relatively small, we not only controlled their profile information but also matched the time they used Weibo; each control user was thus matched to one LOC parent according to criteria of age (40–65 years old), gender, and period of Weibo activity. We also required the control users to have made more than 30 posts in no fewer than six seasons. In all, Sample 2 comprised 36 LOC users and 36 ordinary users with similar profile information and records.

Measures and analysis

Profile information

We utilized our self-made webcrawler to download all the user profile information in Sample 1. The current study primarily focused on two kinds of information: user profile and microblogs. The user profile includes a user's age, gender, and self-defined location. The microblog information includes the following: (1) Statuses_count, the number of posts (including retweets) issued by the user; (2) Original_statuses_ratio, the ratio of original posts issued by the user; (3) Words_avg., the average number of words per post of the relevant account.

Text analysis

We downloaded all of the users' microblogs for Sample 1. The data included the user ID, the time of the post, and the text. We analyzed the content using the Chinese text analysis software TextMind (Gao, Hao, Li, Gao, & Zhu, 2013; Zhao, Jiao, Bai, & Zhu, 2016). TextMind is a text-analysis system based on the Simplified Chinese version of the LIWC (SCLIWC) dictionary (Gao et al., 2013). The SCLIWC dictionary maintains the same construction as the original version. It was first translated from the Traditional Chinese version of LIWC (CLIWC; Huang et al., 2012), with high-frequency words extracted from Chinese SNS added into the lexicon according to the LIWC categories. This system first segments the posts into separate words and then analyses the unit word by word. TextMind measures the percentage of a specific word category within an entire body of text. The data output is in the form of a list of permillage numbers (feature values) beside a list of categories (also called features) of the text. There are different feature values for any given piece of text. As we obtained the timestamp of posts and the date of bereavement, we then tracked the change of word use quarterly over the following 2 years. The mixed linear model was used to examine the effect of time and group.

Table 2. Summary of collected LIWC categories.

Categories	Examples	No. of words
Mood		
Positive emotion	Haha, agree, won, yeah, exited, happy	564
Negative emotion	Vain, sorry, mess, angry, mad, irratate	924
Sad	Aching, lost, alone, sad, cry, tear, sigh	165
Death	Died, bury, dead, death, deceased, despair	126
Parent–child bond		
Family	Dad, mom, boy, girl, baby, mama	139
Lifestyles		
Work	Busy, work, policy, rush, project	596
Achievement	Overcome, plan, try, encounter, gain	370
Leisure	Bar, art, ball, painting, play, rest, spare	344
Religion	Amen, god, hells, pray, bless, lord	283

The three aspects measured in this study were mood, parent–child bond, and lifestyle, each containing several word categories. The aspect of mood was measured by attending to positive emotion words, negative emotion words, its sub-category sad words, and death words. We deliberately calculated sub-category sad words separately because the common mood response to loss of the only child was grief (Chen, 2016; Sidmore, 2000; Yang & Li, 2018). The aspect of parent–child bond was measured using family relation words, which were restricted to core family relations. Given that the deceased child is the only child, the parents lost their identity of father/mother together with the only child. Thus, using family relation words like dad/mom represented a continuing bond with the only child. Lifestyle was measured through work, achievement, leisure and religion words, in accordance with the original structure of LIWC, and as has been validated by many studies (Donohue, Liang, & Druckman, 2014; Zhao et al., 2016). Table 2 offers examples of target words for each category used in this study.

Results

The demographic information of the two samples are shown in Table 3. Our results are set out as follows: we first compared the profile information of the LOC parents and the control group users in Sample 1; a

Table 3. Age and gender distribution of LOC users and common users by sample.

	LOC users in Sample 1	Ordinary users in Sample 1	LOC users in Sample 2	Ordinary users in Sample 2
n	228	226	36	36
Female	133 (58%)	131 (58%)	24 (67%)	24 (67%)
Age				
40 ~ 50	18 (26%)	82 (36%)	4 (40%)	11 (30%)
50 ~ 60	37 (54%)	111 (49%)	6 (60%)	19 (53%)
60~	14 (20%)	33 (15%)	0 (0%)	6 (17%)
N.A.	159	0	26	0

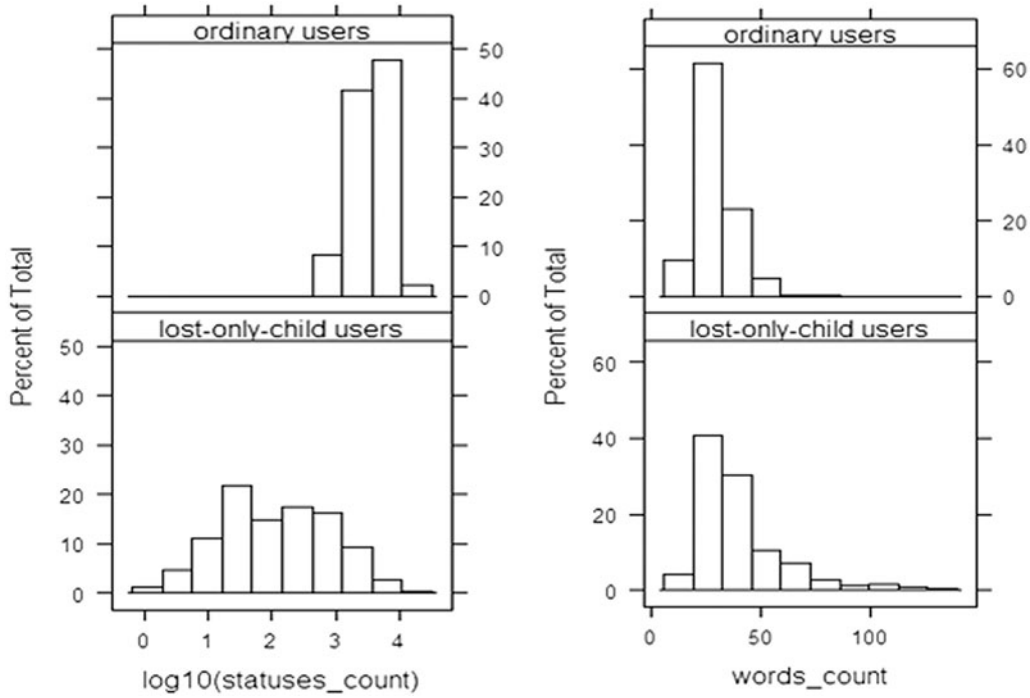

Figure 1. The distribution of status count (left), word count (right). The *x*-axis of status count refers to the base-10 logarithmic transformed value of features and the *x*-axis of word count refers to the original value. The *y*-axis represents the percentage of users.

second section elaborates on the linguistic differences between the two groups; a third analyzes the change of word use over time in the groups of Sample 2.

Differences in user profiles

We analyzed differences in the user profiles of the two groups in Sample 1. As the features yielded a long-tailed distribution instead of a normalized one, we examined the differences using Mann–Whitney non-parametric tests. The results showed that the LOC parents have observably fewer posts ($U = 2181.0$, $p < 0.001$), but that they have made more posts containing original content compared to the control users ($U = 226.0$, $p < 0.001$). Furthermore, LOC parents' posts averaged 39.9 words per post, significantly more than the 28.9 words per post in the control group ($t(452) = 7.417$, $p < 0.001$). Figure 1 shows the distribution of (a) number of posts and (b) average word counts per post of the two groups. In order to better depict the distribution, we took a base-10 logarithmic transformation of these variables.

Group differences in language use

All microblogs of LOC and control group users in Sample 1 were analyzed. Table 4 contains the LIWC feature values of the nine categories. Since the users' LIWC feature values fit a normal distribution curve, we calculated the average LIWC scores and examined any differences in them using the independent sample *t*-test. We found significant differences in all nine categories. In regard to mood, LOC parents preferred using more negative emotional words and fewer

positive emotion words. In addition, the LOC parents used more sad words and death words.

As for the aspect of parent–child bond, the LOC parents talked more about their family members, indicating that they were immersed in the loss of their only child. In the category of lifestyle, the LOC parents used achievement words and work words more frequently than the control users. However, they used fewer leisure words. LOC parents rarely wrote about their own hobbies and interests. The *t*-tests also revealed that LOC parents used more religion words.

As many studies have found that gender is an important factor in predicting posttraumatic adaptation (Wijngaards-de Meij et al., 2005), we examined gender differences in word use and found some interesting results. A MANOVA test revealed that group and gender have an interaction effect on the use of family words [$F(1, 450) = 6.071$, $p < 0.05$]. LOC mothers mentioned their deceased child more frequently than LOC fathers, while this effect was not significant for control users. The LOC mothers had a stronger bond with the deceased child [LOC parents: $t(226) = 3.001$, $p < 0.01$; control users: $t(224) = 0.112$, $p < 0.05$]. In the use of mood words (Figure 2), LOC mothers expressed more negative feelings [$t(224) = 2.938$, $p < 0.001$], while the control group's female users were found to use more positive emotional words [$t(452) = 3.643$, $p < 0.001$]. In both the LOC group and the control group, we found male users talked about their work more often [LOC parents: $t(226) = 2.213$, $p < 0.05$; control users: $t(224) = 5.506$, $p < 0.001$].

Table 4. Group comparisons of LIWC feature values.

	LOC users ($n = 228$)		Control users ($n = 226$)				
	M	SD	M	SD	*t*	*p*	Cohen's d
Mental health							
Positive emotion	1.59	0.78	2.30	0.67	10.419	0.000	0.97
Negative emotion	1.05	0.66	0.87	0.36	3.643	0.000	0.36
Sad	0.49	0.42	0.19	0.10	10.348	0.000	0.98
Death	0.26	0.36	0.14	0.07	4.975	0.000	0.46
Parent–child bond							
Family	0.93	0.84	0.30	0.20	11.006	0.000	1.03
Lifestyles							
Work	2.24	1.12	1.91	0.90	3.474	0.001	0.33
Achievement	0.94	0.60	0.77	0.38	3.600	0.000	0.34
Leisure	1.09	0.70	1.47	0.63	5.983	0.000	0.57
Religion	0.47	0.42	0.40	0.35	2.165	0.031	0.18

Note. To counteract the problem of multiple comparisons, we used Bonferroni correction that test's each individual hypothesis at alpha = 0.05/9 = 0.005.

Changes in word use over time

To track changes in psychological processes, we analyzed the change in word use for Sample 2 in the 2 years after the child died. The Weibo time period monitored for each LOC user differed according to their date of bereavement. Data for the control group were collected from the same data range as that of their matched LOC user. We divided the period into eight subsets according to time and analyzed the eight categories of LIWC feature values of the sub-corpus every three months. Mixed linear models were utilized to analyze the effects of the lost time, as the non-linear fitting did not perform well, and there were no significant results on the second-order effects of time ($p > 0.05$).

Figure 3 shows the trajectory of mood word use. We did not find a significant effect of time [$F(1, 34.035) = 0.113$, $p > 0.005$] or group [$F(1, 81.922) = 1.319$, $p > 0.005$)] on positive emotion word use (Figure 3a). We observed a slightly significant effect of time on negative emotion words use indicating

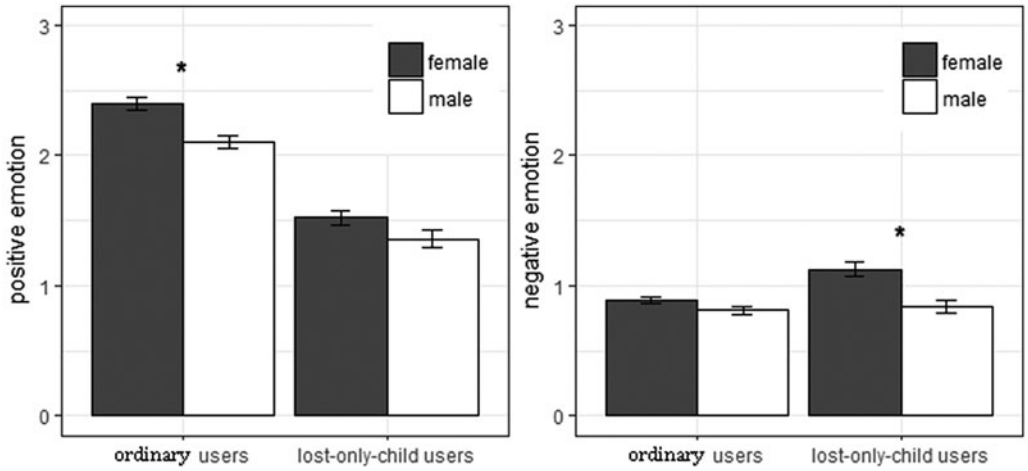

Figure 2. The interaction effects of group and gender on the use of mood words. *y*-Axis represents the permillage of word use. $^{*}p < 0.001$.

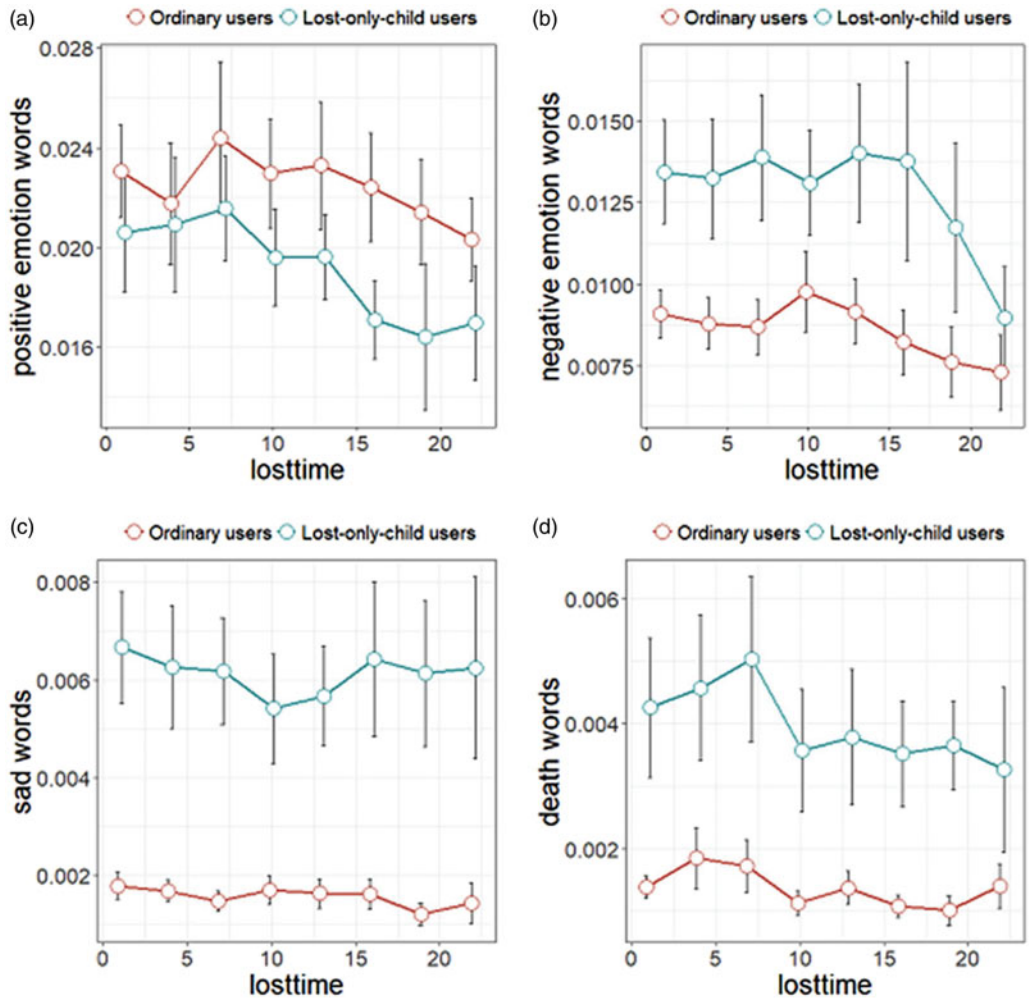

Figure 3. Change in mood word use over time after bereavement. *y*-Axis refers to the permillage of word count in all of the text. Error bar refers to standard error. The mixed linear model fitted well where the linear fitting coefficients were $r_{positive} = 0.94$, $r_{negative} = 0.82$, $r_{sad} = 0.92$, $r_{death} = 0.77$.

decreased use over time [Figure 3b; $F(1, 32.151) = 5.056$, $p < 0.005$]. The LOC parents used fewer negative emotion words after the sixth period, and the group difference vanished at the eighth period ($p > 0.005$). The use of sad words and death words were highly associated with grief; however, the result did not indicate a decrease in those word types over time [$F_{sad}(1, 50.003) = 0.707$, $p > 0.005$; $F_{death}(1, 19.843) = 0.919$, $p > 0.005$].

No significant interaction effects of group and time were found in the use of mood words. However, as shown in Figure 3, there seems to be a trend for the interaction of positive emotion words and negative emotion words. Considering that the current statistic methods might be overly cautious, we analyzed the Bayes factors to reconfirm the existence of the interaction effects. Bayes factors were computed using JASP (Wagenmakers et al., 2018) with default prior width. This showed evidence that the data were more likely under the interaction-existence model compared to the nonexistence model, and interpreted Bayes factors (BF_{10}) of 0.33–1.00 as anecdotal, 0.10–0.33 as substantial, 0.03–0.10 as strong, 0.01–0.03 as very strong, and <0.01 as decisive evidence (Hu, Kong, Wagenmakers, Ly, & Peng, 2018). In all Bayesian analyses reported, we included gender as a covariance factor. The BF_{10} of repeated ANOVA interaction effects of positive emotion words use was 0.329, and that of negative emotion words use was 0.396, indicating weak support for the no interaction effect of bereaved time and group based on this dataset. Meanwhile, the BF_{10} of the interaction effects of sad words and death words were 0.013 and 0.014 separately, providing substantial evidence for the null hypothesis that there is no difference between bereaved parents and ordinary users their word use from the two categories over time.

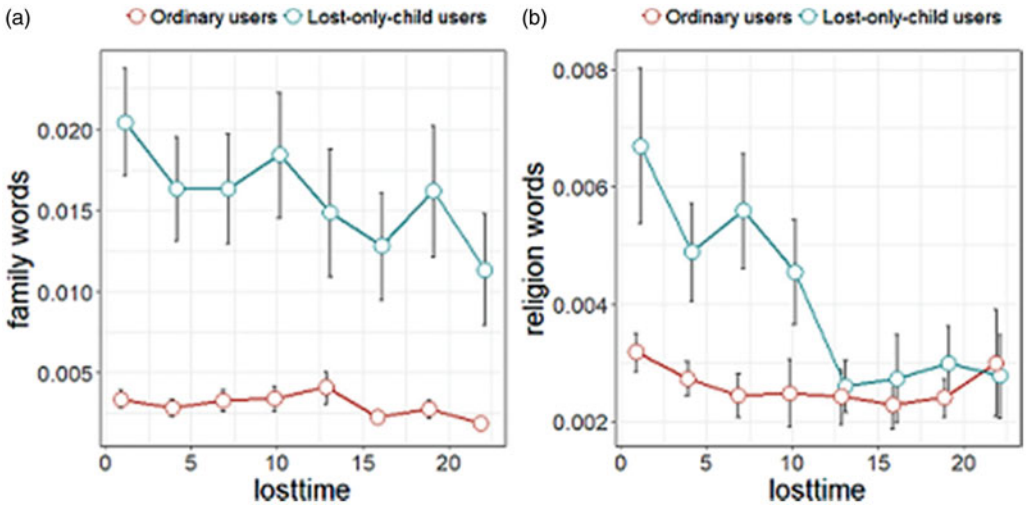

Figure 4. Change in personal concerns since bereavement. *y*-Axis refers to the permillage of word count in all the text corpus. Error bar refers to standard error. The linear model fitted well where the regression coefficients were $r_{family} = 0.92$, $r_{religion} = 0.88$.

As for the aspect of parent–child bond, the results indicated a decrease in the use of family words (see Figure 4a). Within the first 2 years after the child's death, the LOC parents used significantly more family words compared to the control users [$F(1, 112.228) = 45.027$, $p < 0.001$], a difference which decreased over time [$F(1, 389.717) = 8.757$, $p < 0.005$]. The interaction effect is significant as the LOC parents reduced their use of family words while the use of family words in control users did not change over time [$F(1, 389.717) = 4.180$, $p > 0.005$]. However, the differences between groups did not entirely dissipate during the 2 years of the study.

With respect to the aspect of lifestyle, neither time nor group was found to have a significant effect on the use of work, achievement or leisure words in the first 2 years after the only child died. An interaction effect [$F(1, 395.010) = 9.325$, $p < 0.005$] was observed in the use of religion words (see Figure 4b.). As time went by, the LOC parents used religion words less frequently. The between-group variances sharply decreased, and the between-group differences vanished in the fifth time period ($p > 0.005$).

Discussion

This study examined the development of psychological status based on the word use of a sample of LOC parents in China. Specifically, the current study investigated the trajectory of the dynamic psychological process quarterly over the first 2 years after the bereavement. We identified several patterns of word use after bereavement based on these records, which may be useful for understanding the psychological process of parents in China after the death of their only child.

In terms of the aspect of mood, the LOC parents gradually reduced their high-frequency use of negative emotion words over time, but the permillage of sad and death words remained high. Our findings were consistent with studies based on LOC parents and Western bereaved parents that found that bereaved parents had more negative emotions and fewer positive emotions (Baddeley & Singer, 2008; Schwartz & Drotar, 2004), which indicated a higher possibility for mental health problems. Despite the reduction of negative emotion words over time, the use of sad words and death words did not decrease. This finding suggests that although the overall emotion process seems to be normal, the grief can recur over a lifetime.

In terms of the parent–child bond, the LOC parents mentioned family relationship words several times more than their ordinary peers. The results also demonstrated that this strong connection was gradually loosening as time elapsed. Although there is a cultural stigma involved in mentioning deceased children (Quinn & Chaudoir, 2009), many LOC parents in the current study, especially mothers, showed strong parent–child continuing bonds, a fact which coincides with studies based on Western bereaved samples (Getty et al., 2011). However, an overly strong after-death connection was found to be a risk factor for anxiety, depression and complicated grief (Field & Filanosky, 2009; Yu, He, Xu, Wang, & Prigerson, 2016), and worked against adjustment after

the bereavement. As posttraumatic-growth was found in Western bereaved samples (Stockton et al., 2014), we hypothesized that LOC parents' connection with their deceased children would also gradually loosen. The results have supported this hypothesis. In this study, the parents gradually decreased the frequency with which they mentioned their child over time, indicating that their parent–child bonds became gradually less strong. However, the LOC parents still held a much stronger parent–child bond than the comparison group after 2 years. It is supposed that the LOC parents, especially mothers, were immersed in the painful event and that time played an important role in accepting both the bereavement and a new identity as LOC parents (Frost, 2011; Zheng & Lawson, 2015).

Concerning lifestyles, the LOC parents used fewer leisure words and more of both work and achievement words, living a productive life according to the overall word use analysis. On one hand, devoting oneself to work or achievement is a way to avoid thinking about the traumatic event and to improve mental health (Stansfeld, 2002). On the other hand, the death of the only child brings financial stress for elder parents (Mcsherry, Kehoe, Carroll, Kang, & Rourke, 2007), forcing them to put more effort into work and achievements and spend lesser time on leisure activities in order to support themselves into old age. However, these differences were not observed in the first 2 years after bereavement. Future studies with longer research periods are needed to analyze these changes in lifestyles.

In addition, a significant proportion of LOC parents temporarily turned to religion at the beginning of their bereavement. We found a temporarily high-frequency use of religion words during the first year after loss. Religion introduces a higher force that may be potent during the time of bereavement, and previous studies have suggested that religion is helpful in adjusting to loss (Currier, Mallot, Martinez, Sandy, & Neimeyer, 2013; Wortmann & Park, 2008). It can also offer new philosophies that might help people accept their loss. We only observed this increased use of religion words at the beginning of the bereavement period, a fact which might be explained by a gradual acceptance of the death and subsequent support from the community of LOC parents. It is an interesting phenomenon that the Chinese LOC parents only temporarily turned to religion instead of permanently converting to it. The role of religion in healing previously unreligious LOC parents is worth discussing in the future.

Meanwhile, we found an interesting coincidence in the fact that changes in word use, including positive emotion words, negative emotion words, death words and religion words, all began after the fourth quarter, within which lay the anniversary of the bereavement. For example, the use of both negative and positive words began to fall, and the use of family words started to stabilize and reach an ordinary level. In Chinese culture, the first death anniversary is an important time to say goodbye to the deceased. Given that all the LOC parents enrolled in the study survived at least the first two most painful years after bereavement, we considered that the results of the after-anniversary growth indicate that the first anniversary may be a positive phenomenon for the survivors. However, the first death anniversary is also very dangerous due to the "anniversary effect" found in both Chinese (Chow, 2009) and Western samples (Rostila, Saarela, Kawachi, & Hjern, 2015), which refers to a higher probability of acute health events around the anniversary. How to successfully get through the first death anniversary and grow mentally is a worthwhile question for exploration in future studies.

Several useful strategies for improving the well-being of LOC parents can be generated from the existing findings. First, considering the character of word use among Chinese LOC parents, it might be helpful to offer a life-long counseling service, as we found that the health impacts of bereavement can last for a very long time. Secondly, it is necessary to provide material support to the LOC parents, especially when the deceased child was their only source of income. Thirdly, organizing leisure activities, such as singing or dancing, might be helpful for speeding up the process of identity reconstruction. Besides, appropriate religious activities would be a strong help for escaping the sense of despair and injustice, especially during the first several months of bereavement. It is also important to promote connections with LOC parents and to enhance support from the community, especially during the first year after bereavement. Future studies could examine the effectiveness of these strategies.

This study utilized text analysis to interpret the parents' psychological state. The word count system can efficiently code language use, analyze emotional status, and perform other tasks; the importance of this system has emerged in the field of psychology (Bazarova, Taft, Choi, & Cosley, 2013; Burke & Dollinger, 2005; Ireland & Pennebaker, 2010). We can repeatedly measure word use within the body of a text at different time periods, which provides an easy method for collecting longitudinal data from OSNs.

Meanwhile, as conducting research on the posts is non-invasive, this method is considered more sensitive and respectful to the bereaved parents and their deceased child (Getty et al., 2011). However, text analysis also has its downsides. As word use can only reflect part of anyone's psychological status, it may not lead to the identification of a complex psychological problem such as complicated grief and depression.

Several more limitations should also be mentioned. First, we used an intervention-free method in our sampling process by only obtaining public data. As only a few LOC parents had provided the date of their child's death, the sample size in our study is relatively small. The longitudinal study only contained 36 pairs of LOC parents and their comparison users. Though large effect sizes were found along with the significant results, a larger group design would have provided a more reliable statistical conclusion for the non-significant results. Secondly, as we used a snowball sampling method, the LOC parents were connected with each other, which may have increased the homogeneity of word use. These connections limit the ability to generalize these findings to groups beyond the explored LOC community. Thirdly, this study is only based on Sina Weibo. Thus, these findings may not be generalizable to samples not using this specific OSN. Finally, as we recruited our data from an OSN, we did not have exact demographic information with respect to factors such as the ages of the children and the circumstances of their death. These variables should also be considered in future studies.

A final limitation involves the sensitivity and validity of the use of TextMind, the Simplified Chinese version of the LIWC system. Although Zhao et al. (2016) demonstrated that sensitivities were over 0.77 in all categories in the current study, the word count system may still not be sensitive enough due to the limited lexical coverage of the dictionary. Also, it has been suggested that word count methods are limited because they cannot recognize irony or sarcasm and are crude in dealing with context (Pennebaker & Stone, 2003). Although it is important to identify the specific meaning of words in different contexts, the unique word choices can be telling on their own.

In this study, we found that the loss of the only child has a profound impact on LOC parents' emotional and cognitional process, which was reflected in their word use. During the first 2 years of bereavement, we measured the LOC parents' word use on Weibo quarterly. We identified psychological development patterns over time. From the aspect of mood, the use of sad words and death words did not decease along with time; the LOC parents held a strong parent–child bond and gradually adjusted to the loss. The LOC parents turned to the help of a higher spiritual force shortly after their child died. Meanwhile, changes in the psychological process began after the first anniversary of bereavement. Exploring psychological development patterns after the loss of the only child can improve our understanding of LOC parents' inner processes, thereby aiding us in designing and offering them targeted help.

Disclosure statement

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