Stress-Buffering Pattern of Positive Events on Adolescents: An Exploratory Study based on Social Networks

Abstract

Stress is viewed as the leading cause of public mental health issues. Positive events, however, could act as a buffer against stress. Since the stress-buffering effect of positive events in previous studies was mainly examined by subjective self-reporting, continuous tracking research at individual behavioral levels still remains to be explored. In this study, We collected microblogs (n=29,232) from a high school student group (n=500) to examine the relationship between positive events and stress-buffering pattern based on microblog content and behavioral characteristics. Through a pilot study we found that the stress-buffering pattern of school scheduled positive events (n=259) was manifested in both the reduction of stress intensity, the shorter duration of stress intervals, and talking less about academic words on micro-blog. Hypothetical tests for stress-buffering pattern and monotonic effect of stress changes were further conducted based on automatical extracted positive events (n=1,914) from microblogs. The stress-buffering pattern of positive events was closely correlated with posting behavior (ratio = 80.65%, SD=1.96), stress change mode (ratio = 67.74%, SD=2.04) and microblog linguistic expressions (ratio = 74.19%, SD=2.07). Positive events conducted most intensive stress-buffering impact on stress from 'family life' (ratio = 83.87%, SD=2.72), followed by 'peer relationships' (ratio = 71.77%, SD=4.04) and 'school life' (ratio = 67.74%, SD=2.71) dimensions. Positive events buffered monotonous stress changes at both the early (11.88% reduction) and late stages (5.88% reduction). Further, the stress-buffering patterns of positive events were incorporated into the prediction of adolescents' future stress. This study could inform the use of social network to reach and track the mental status transition of adolescents under stress. The theoretical and practical implications, limitations of this study and future work were discussed.

Keywords: stress-buffering, positive events, microblogs, adolescents

1. Introduction

Motivation: Life is always full of ups and downs. Accumulated stress could drain inner resources, leading to psychological maladjustment, depression and even suicidal behaviours (Nock et al., 2008). Compared with adults, young people exhibit more exposure to stress due to the immature inner status and lack of experience (Vitelli, 2014). According to the latest report released by American Psychological Association in 2018, 91% of youngest adults had experienced physical or emotional symptoms due to stress in the past month compared to 74% of adults (APA, 2018). More than 30 million Chinese adolescents are suffering from psychological stress, and nearly 30% of them have a risk of depression (Youth and Center, 2019). Stress-induced mental health problems are becoming an important social issue worldwide.

On the other hand, positive life events, such as satisfying social interactions, excellent academic performance and pleasant entertainment activities, could exert protective effects on emotional distress in both directly and indirectly ways by *'buffering'* (Shahar and Priel, 2002; Cohen and Hoberman, 2010), with respect to physiological, psychological, and social coping resources (Cohen et al., 1984; Needles and Abramson, 1990). Researchers indicated that positive events mitigated the relation between negative events and maladjustment in samples of adolescents experiencing family transitions (Doyle et al., 2003). The written expression of positive feelings had also been proven to prompt increased cognitive re-organization among an undergraduate student group (Coolidge, 2009). Positive events also have been linked to medical benefits, such as improving mood, serum cortisol levels, and lower levels of inflammation and hypercoagulability (Caputo et al., 1998; Jain et al., 2010). Thus, tracking the state of stress-buffering is important for understanding the mental status of stressed individuals.

Existing solutions: Previous studies have been focusing on conducting one-time measurement of positive events and stress-buffering state after events, i.e., Hassles & Uplifts Scales (Kanner et al., 1981), Perceived Benefit Scales (Mcmillen and Fisher, 1998), Interpretation of Positive Events Scale (Alden et al., 2008) and Adolescent Self-Rating Life Events Checklist (Jun-Sheng, 2008). Recent scholars have demonstrated the feasibility to sense and predict users' stress from social networks (Xue et al., 2013, 2014; Lin et al., 2014; Li et al., 2015b,c,a, 2017a,b), through content (linguistic text, emoticons, pictures) and behavioral (abnormal posting time, comment/response actions) measures.

The aforementioned could be viewed as static sensing of stress-buffering..... The subjective self-report investigations were limited by manpower, and susceptible to many factors, such as social appreciation and pressure from measurement scenarios.

Another difference from the previous work lies in that ..

Our work: To this end, the current study aims to examine the potential relationship between positive events and its stress-buffering pattern from adolescents' microblog content and behavioral characteristics. We aim to continually mine the restoring impact of positive events leveraging abundant data source from microblogs, to further provide guidance for school and parents that when and which kind of positive events could help relieve students' overwhelmed stress in both stress prevention and stress early stopping situations.

However, capturing the stress-buffering process of positive events is not a trivial task. Two fundamental challenges need to be addressed: 1) What is the latent connection between positive events and adolescents' stress-buffering reflections from microblogs? 2) What is counted as a stressful period buffered by a positive event?

In this paper, a pilot study was firstly conducted on the microblog data set (n=29,232) of a group of high school students (n=500) associated with the school's scheduled positive events (n=259) and stressor events (n=518). After observing the posting behaviors and contents of stressed students under the influence of positive events, several implications were discussed to guide the next step research.

We extract uplift events and the corresponding impacted interval from microblogs. We define and extract structural uplift events from posts using linguistic parser model based on six-dimensional uplift scale and LIWC lexicons. Independent stressful intervals (SI) and stressful intervals impacted by uplifts (U-SI) are extracted considering temporal orders. A Chinese linguistic parser model was applied to extract structural positive events.

We examined the relationship between the stress-buffering pattern of positive events and adolescents' microblog characteristics through three groups of measures (posting behaviour, stress change mode, linguistic expressions). The stress-buffering effect was modeled as the statistical difference in two comparative situations. and model the impact of uplift events as the statistical difference between the sets of SI and U-SI in two aspects: the two-sample based method is employed for variation detection, and the t-test correlation is conducted to judge the monotonous correlation. We also tracked the dynamic process of stress-buffering pattern, and quantify the monotonous stress-buffering impact in temporal order.

The stress-buffering pattern are integrated into stress prediction.

The rest of the paper is organized as follows. We introduce related works in section **??**, and conduct the data observation in section **??**. The preliminaries and problem formulation are presented in section **??**. We conduct the procedure for extracting uplift events and identifying the impact interval in section **??**, and introduce the detailed method for analyzing the restoring impact of uplift events in section **??**. We present the experimental results in section **??**, and discuss the future work in section **??**.

2. Literature Review

2.1. Stress-buffering Function of Positive Events

Positive events have been verified as protective factors against daily stress (Ong et al., 2006; Bono et al., 2013), loneliness (Chang et al., 2015), suicide (Kleiman et al., 2014) and depression (Santos et al., 2013). Through exploring naturally occurring daily stressors, (Ong et al., 2006) found that over time, the experience of positive emotions functions to assist high-resilient individuals to recover effectively from daily stress. Through a three-week longitudinal study, (Bono et al., 2013) examined the correlation between employee stress and health and positive life events, and concluded that naturally occurring positive events are correlated with decreased stress and improved health. (Chang et al., 2015) investigated the protective effect of positive events in a sample of 327 adults, and found that the positive association between loneliness and psychological maladjustment was found to be weaker for those who experienced a

high number of positive life events, as opposed to those who experienced a low number of positive life events. This is assistant with the conclusion made by (Kleiman et al., 2014) that positive events acted as protective factors against suicide individually and synergistically when they co-occurred, by buffering the link between important individual differences risk variables and maladjustment. In the survey made by (Santos et al., 2013), strategies of positive psychology were also checked as potentially tools for the prophylaxis and treatment of depression, helping to reduce symptoms and for prevention of relapses.

The protective effect of positive events was hypothesized to operate in both directly (i.e., the more positive events people experienced, the less stress they perceived) and indirectly ways by *'buffering'* the effect of stressors (Cohen and Hoberman, 2010; Shahar and Priel, 2002), with respect to physiological, psychological, and social coping resources (Cohen et al., 1984; Needles and Abramson, 1990). (Folkman and Moskowitz, 2010) identified three classes of coping mechanisms that were associated with positive emotion during chronic stress: positive reappraisal, problem-focused coping, and the creation of positive events. Due to the immature inner status and lack of experience, adolescents exhibit more sensitive to stressors (i.e., exams, heavy homework, isolated by classmates, family transitions), living with frequent, long-term stress (Vitelli, 2014). In this situation, positive events could help reinforce adolescents' sense of well-being (Coolidge, 2009), restore the capacity for dealing with stress (Doyle et al., 2003), and also have been linked to medical benefits, such as improving mood, serum cortisol levels, and lower levels of inflammation and hyper coagulability (Jain et al., 2010; Caputo et al., 1998). The present study will be based on the consensus conclusions from the above studies.

To assess the stress-buffering effect of positive events, scholars conducted many studies based on self-support methods. For example, (Kanner et al., 1981) conducted Hassles & Uplifts Scales, and concluded that the assessment of daily hassles and uplifts might be a better approach to the prediction of adaptational outcomes than the usual life events approach. To measure negative interpretations of positive social events, (Alden et al., 2008) proposed the Interpretation of Positive Events Scale, and analyzed the relationship between social interaction anxiety and the tendency to interpret positive social events in a threat-maintaining manner. (Mcmillen and Fisher, 1998) proposed the Perceived Benefit Scales as the new measures of self-reported positive life changes after traumatic stressors, including lifestyle changes,

material gain, increases in self efficacy, family closeness, community closeness, faith in people, compassion, and spirituality. Specific for college students, (Jun-Sheng, 2008) investigated in 282 college students using the Adolescent Self-Rating Life Events Checklist, and found that the training of positive coping style was of great benefit to improve the mental health of students. The above explorations based on self-report investigations were difficult to exclude interference from external factors (i.e., social appreciation, pressure from measurement scenarios). Meanwhile, due to the lack of manpower and effective scientific methods, most scholars relied on a limited number of measurements, thus continuous measurements of stress-buffering process were difficult to carry out.

2.2. Measures and Stress Analysis from Social Networks

As billions of adolescents are recording their life through social networks (e.g., micro-blog, Twitter, Facebook), researchers explored to apply psychological theories into social network based data mining techniques, thus to better understand user' psychological status from the self-expressed public data source. Multiple content and user behavioral measures have been proven effective in user mental health analysis, including time series curve analysis of stress (Li et al., 2015b,a), topic words (Xue et al., 2013), abnormal posting time (Xue et al., 2014), online shopping behaviors (Zhao et al., 2016), human mobility features (Jin et al., 2016), comment/response actions (Liang et al., 2015) and high dimensional multimedia features (Lin et al., 2014). For example, (Xue et al., 2013, 2014) proposed to detect adolescent stress from single post utilizing machine learning methods by extracting stressful topic words, abnormal posting time, and interactions with friends. (Lin et al., 2014) constructed a deep neural network to combine the high-dimensional picture semantic information into stress detecting. Based on the stress detecting result, (Li et al., 2015c)Li et al. (2015a)Li et al. (2015b) adopted a series of multi-variant time series prediction techniques (i.e., Candlestick Charts, fuzzy Candlestick line, Seasonal Autoregressive Integrated Moving Average model) to predict future stress trend. Taking the linguistic information into consideration, (Li et al., 2017b) employed a Nonlinear autoregressive with External Input Neural Network to predict a teen's future stress level referred to the impact of co-experiencing stressor events of similar companions. (Li et al., 2017a) proposed to detect stressor events from microblog content and analyze stressful intervals based on posting rate. All above studies focused

on the discussion of stress detection on social networks. This paper starts from a completely new perspective, and focuses on the stress-buffering effect of positive events in adolescents' stress coping process. Thus we push forward the study from how to find stress to the next more meaningful stage: how to cope with stress.

2.3. Correlation Analysis Models for Multivariate Time Series

Basic correlation analysis models on time series focused on univariate data have been well studied. As the most widely adopted model, the Pearson correlation analysis Cohen et al. (1988) measures the linear correlation between two variables X and Y. One inevitable defect of Pearson correlation is its sensitivity to outlier values. To overcome such drawback, Spearman Rank correlation Spearman (1987) and Kendall Rank correlation Mcleod (2011) were proposed based on Pearson correlation. While Pearson correlation estimates linear relationships, Spearman correlation estimates monotonic relationships (whether linear or not), and are calculated as the Pearson correlation between the rank values of two variables. The Kendall Rank correlation mainly assesses the similarity of the orderings of the data when ranked by each of the quantities. The above correlation models are usually used to estimate relationship between single-dimensional variables, and cannot be adopted directly in social network based scenario.

For multivariate time series analysis, two-sample based models were widely adopted. Such kind of models were deduced to check whether two samples come from the same underlying distribution, which was assumed to be statistically unknown. Correspondingly, various kernel (Scholkopf et al., 2006) and distance-based models (Schilling, 1986) were proposed. (Scholkopf et al., 2006) proposed to transform the distance between two variables and nearest neighbors into a reproducing kernel hilbert pace, and solve the problem using Maximum Mean Discrepancy. (Schilling, 1986) adopted the r-nearest neighbor based model to partition two set of event driven time series data. The global proportion of the right divided neighbors were calculated to estimate whether there existed statistically difference between the two sets. This paper adopted the r-nearest neighbor based two-sample model in our problem, thus to measure the distance and correlation between two multi-dimension variables depict the stress-buffering patterns of positive events.

3. Data Observation: A Pilot Study on the Stress-buffering Effect of School Scheduled Positive Events

Microblogs. Microblogs of students coming from Taicang High School, were collected from January 1st, 2012 to February 1st, 2015. We filtered out 124 active students according to their posting frequency from over 500 students, and collected their microblogs throughout the whole high school career. Totally 29,232 microblogs were collected in this research, where 236 microblogs per student on average, 1,387 microblogs maximally and 104 posts minimally. To protect the privacy, all usernames were anonymized during the experiment.

Scheduled events. The list of weekly scheduled school events, with detailed description involved in the event (grade, exact start and end time), were collected from the school's official website[1] from February 1st, 2012 to August 1st 2017. There were 122 stressor events and 75 positive events in total. Examples of scheduled positive and stressor events in high school life are listed shown in Table 1. There were 2-3 stressor events and 1-2 positive event scheduled per month in current study. Figure 1 shows three examples of a student's stress fluctuation during three mid-term exams, where the positive event *campus art festival* was scheduled ahead of the first exam (*example a*), the positive event *holiday* happened after the second exam (*example b*), and no scheduled positive event was found nearby the third exam (*example c*).

Table 1: Examples of school scheduled positive and stressor events.

Type	Date	Content	Grade
stressor event	2017/4/16	*first day of mid-term exam*	grade1,2
positive event	2016/11/5	*campus art festival*	grade1,2,3

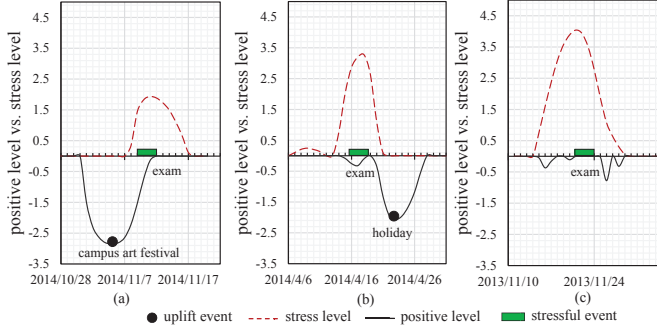[1]http://stg.tcedu.com.cn/col/col82722/index.html

Figure 1: Examples of school scheduled positive events, stressful events, and a student's stress fluctuation

To further observe the effect of positive events on stressed students, we collected all stressful intervals surround the scheduled exams over the 124 students during their high school career applying the interval detection method in (Li et al., 2017a). For each student, we divided all stressful intervals into two sets: 1) In the original sets, stress was caused by a stressor event, lasting for a period, and no other intervention (namely, positive event) occured. We called the set of such stressful intervals as **SI**; 2) In the other comparative sets, the stressful interval was impacted by a positive event(i.e., uplifts), we called the set of such stressful intervals as **U-SI**. Thus the difference under the two situations (sets) could be seen as the stress-buffering effect conducted by the positive event. We identified 518 exam related stressful intervals (SI) and 259 stressful intervals impacted by four typical scheduled positive events (U-SI) ('practical activity', 'new year party', 'holiday', 'sports meeting') from the students' microblogs. Five measures during the above two conditions were considered: the *accumulated stress*, the *average stress* (per day), the *length of stressful intervals*, the *frequency of academic topic words*, and the *ratio of academic stress among all types of stress*. .... Examples of topic words for each type of positive event were listed in table 2. Examples of academic related keywords were listed in table 3. The average value of each measure over all eligible slides was calculated. Since our target was to track the stress-buffering effect of positive events for students under stress, based on previous research Xue et al. (2013), we detected the stress level (ranging from 0 to 5) for each post. For each student, the stress value per day was aggregated by calculating the average stress of all posts. The positive level of each post was identified based on the frequency of positive words.

Table 3: Examples of academic related keywords.

exam, fail, review, score, test paper, rank, pass, math, chemistry homework, regress, fall behind, tension, stressed out, physics, nervous, mistake, question, puzzle, difficult, lesson, careless

3.1. Results

As shown in figure 2, comparing each measure of scheduled exam intervals under the two situations: 1) existing neighbouring positive events (U-SI) or 2) no neighbouring scheduled positive events (SI), we found that students during exams with neighbouring positive events exhibited less average stress intensity (78.13% reduction in average stress, 95.58% reduction in cumulative stress) and shorter duration of stress intervals (23.30% reduction). Further, the frequency of academic topic words (table 3 for examples) and the ratio of academic stress in each interval were calculated. Results in figure 2 shows that most students talked less about the upcoming or just-finished exams when positive events happened nearby, with lower frequency (84.65% reduction) and lower ratio (89.53% reduction). The statistic result shows clues about the stress-buffering effect of scheduled positive events, which is constant with the psychological theory (Cohen et al., 1984; Cohen and Hoberman, 2010; Needles and Abramson, 1990), indicating the reliability and feasibility of the microblog data set. However, this is an observation based on specific scheduled events, and cannot satisfy the need for automatic, timely, and continuous perception of stress-buffering process. Therefore, next, we will propose a framework to automatically detect positive events and its impact interval. Based on this, the relationship between stress-buffering effect of automatically extracted positive events and microblog characteristics will be discussed.

Table 2: Examples of topic words for positive events.

| dimension	example words	total
entertainment	hike, travel, celebrate, dance, swimming, ticket, shopping, air ticket, theatre, party, Karaoke, self-driving tour, game, idol, concert, movie, show, opera, baseball, running, fitness, exercise	452
school life	reward, come on, progress, scholarship,admission, winner, diligent, first place, superior hardworking, full mark, praise, goal, courage, progress, advance, honor, collective honor	273
romantic	beloved, favor, guard, anniversary, concern, tender, deep feeling, care, true love, promise, cherish, kiss, embrace, dating, reluctant, honey, sweetheart, swear, love, everlasting, goddess	138
pear relation	listener, company, pour out, make friends with, friendship, intimate, partner, team-mate, brotherhood	91
self-cognition	realize, achieve, applause, fight, exceed, faith, confidence, belief, positive, active, purposeful	299
family life	harmony, filial, reunite, expecting, responsible, longevity, affable, amiability, family, duty	184
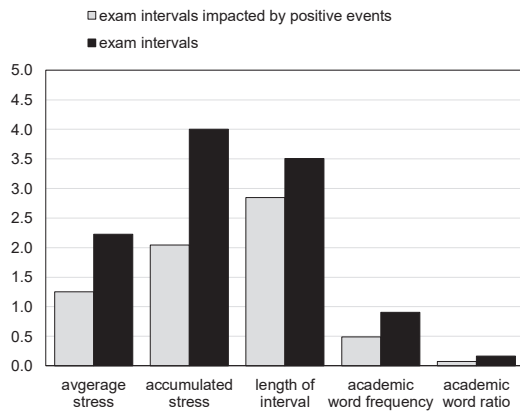
Figure 2: Comparing students' stress during exam intervals in two situations: 1) intervals affected by neighboring positive events (U-SI), 2) no positive events occurred nearby (SI)

4. Literature Review

5. Framework

5.1. Discovery of Positive Events from Microblogs

5.2. Relationship Between Positive Events and Adolescents' Stress-buffering Behaviors from Microblogs

5.2.1. Topic

5.2.2. Stress

5.2.3. Positive and Stressful Emotions

5.2.4. Posting Behaviors

5.3. Modeling the Stress-buffering Impact of Positive Events

5.4. Integrating the Stress-buffering Impact into Stress Prediction

6. Experiment and Evaluation

6.1. Setup and Metrics

6.2. Stress Buffering

6.3. Stress Prediction

7. Reference

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