Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Matthew Graci DATE

Narrating the Stories of Our Lives Over Time and its Functional Implications for Our Health

By

Matthew Edward Graci
Doctor of Philosophy

Psychology

_____

Robyn Fivush, Ph.D.
Advisor

_____

Patricia Bauer, Ph.D.
Committee Member

_____

Marshall Duke, Ph.D.
Committee Member

_____

Regine Haardörfer, Ph.D.
Committee Member

_____

Phillip Wolff, Ph.D.
Committee Member

Accepted:

_____

Lisa A. Tedesco, Ph.D.
Dean of the James T. Laney School of Graduate Studies

_____

Date

Narrating the Stories of Our Lives Over Time and its Functional Implications for Our Health

By

Matthew E. Graci
M.A., Emory University, 2015
M.Ed., Vanderbilt University, 2013
B.A., University of Dayton, 2011

Advisor:
Robyn Fivush, Ph.D.

Committee Members:
Patricia Bauer, Ph.D.
Marshall Duke, Ph.D.
Robyn Fivush, Ph.D.
Regine Haardörfer, Ph.D.
Phil Wolff, Ph.D.

An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
in Psychology
2018

Abstract

By Matthew E. Graci

The manner in which people narrate their past experiences is indicative of their present psychological states. A plethora of studies demonstrate that how people structure their personal experiences in a coherent manner (e.g., give it a theme, context, and sense of chronology) and layer it with an element of integrative meaning (e.g., expressing growth from an experience) concurrently relates to a number of health benefits (e.g., higher life satisfaction, lower depression; Adler, Lodi-Smith, Phillippe, & Houle, 2016). Yet there are still looming questions over the relationship between narrative and health over and above personality traits and cognitive factors, and stability of relations across time. The present research collected data from 300 participants from an online community sample, ages 18 to 29, for a five time-point longitudinal study (62% retention), writing about highly positive and negative experiences, as well as a completed a series of individual difference measures at each time-point. Across three studies, I addressed the following objectives with this dataset: 1) to examine the incremental validity of narratives; 2) to examine the possible longitudinal effect of narrative on health; and 3) to implement machine learning approaches for specifying the extent to which narrative expressions relate to health. The main findings were threefold: 1) narrative expressions matter over and above verbal ability and personality variables to understand health indices; 2) narrative expressions consistently predict health over five points in time, over and above verbal ability and personality variables; and 3) implementing a machine learning algorithm helps derive a new indicator of narrative coherence that provides insights into the construct of coherence. These results further support that personal narratives provide a window into how people are making sense of their experiences over time in the service of understanding themselves and their emotions.

Narrating the Stories of Our Lives Over Time and its Functional Implications for Our Health

By

Matthew E. Graci
M.A., Emory University, 2015
M.Ed., Vanderbilt University, 2013
B.A., University of Dayton, 2011

Advisor: Robyn Fivush, Ph.D.
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in Psychology
2018

Acknowledgements

I would like to thank my advisor, Dr. Robyn Fivush, for her incalculable support as a personal and professional mentor while at Emory. I would also like the many people who helped me with my dissertation project, including: Jordan Booker, Ann Powers, Josh Perlin, Talah Bakdash, Nava Amalford, Namrata Verghese, and Rayna Gorstein. Lastly, I would also like to thank my family for their support during my graduate training. I could have not this project without the people listed here, as well as others, and I greatly appreciate the many who supported me throughout this project and my entire graduate training.

Table of Contents

List of Tables

List of Figures

List of Appendixes

General Introduction

The manner in which people narrate their past experiences appears to have a lasting impact on their psychological health. Storying experience in a structured manner theoretically allows one to process one's thoughts and feelings, and aids in facilitating positive health (e.g. higher life satisfaction, well-being, and physical health) related to the event. Thus, storying past experiences may serve a crucial emotion-regulation function in daily life (Bluck, Alea, Habermas, & Rubin, 2003; Fivush, 2011). The underlying mechanism, however, linking narrative expression to health is subject to scrutiny, both in its incremental validity over and above other factors and its lasting effect on health over time. Elucidating this mechanism can help support why we remember our personal past the ways we do and how such narration affects our sense of health. In order to study this putative narrative mechanism, my dissertation has three major objectives : 1) to examine the *incremental validity* of narratives in order to further specify the relation of narrative processing to health over and above other personality and cognitive factors; 2) to examine the possible *longitudinal effect* of narrative on health by studying the covariation of narrative processing and health over time with a two month longitudinal analysis; and 3) to use *machine learning* approaches for more discovery based approaches to further specify the extent narrative processing relates to well-being.

To examine the first issue of incremental validity, one needs to investigate the extent to which narrative expression uniquely relates to health, over and above other factors (e.g. character traits and general language usage). The majority of narrative research is carried out from a personality psychology perspective, using narrative as a window of investigation into personhood, self-identity, and well-being. This is an important perspective, but there is less focus on the underlying cognitive aspects of narrative expression. Without focusing on the specific

mechanisms by which narrative may facilitate lasting effects on health, the unique predictive influence of narrative might be incorrectly specified. Moreover, the confounding variables that have been addressed thus far in the literature are predominately personality factors. I argue that personal narratives are a cognitive autobiographical memory phenomenon, related to, but distinct from, other cognitive factors, such as verbal ability; thus I will examine possible *cognitive mechanisms* related to narrative processing, and how narratives may be uniquely related to health.

To examine the second issue of longitudinal effect, I focus on looming questions over the relation between narrative and health across time. Very few studies look at both narrative and health over multiple points in time. As such, it's still difficult to determine if there are unique and consistent relations between narrative and multiple indices of health over time—that narrative is a robust predictor of health. This is critical question to address since both narrative expression and health dynamically change. Whereas we know that there is incremental validity to the relation between narrative and health at a single time point, we do not know these relations have a *lasting effect*. Thus, the central question of this study is whether narrative uniquely and consistently explains health; that is, is narrative a robust indicator of health over time?

To examine the third issue of the burgeoning role of machine learning in the narrative field, I will use cutting edge computational tools to discover new psychological insights. These tools have promising predictive power and precision, yet are largely lacking a strong psychological foundation to explain the relations between the factors of interest. For example, Facebook and Twitter posts can predict levels of depression, anxiety, personality traits, and even county-level heart mortality rates (Eichstaedt et al., 2015; Schwartz et al., 2013; Schwartz et al., 2014). However, many of these predictions lack a theoretical motivation behind them. Why does

language usage predict county level heart mortality rates? Incorporating narrative theory into these computational approaches allows for exciting new predictions within a psychologically motivated backdrop to explain mechanism. In particular, we can examine the construct of narrative coherence from more angles using the machine learning methods.

In order to critically examine these issues, I first provide a broader overview of the narrative literature to place these questions in context. I examine research that focuses on the specific aspects of narrative expression that relate to health; discuss past research on the extent narrative processing is an enduring indicator for health; and then how machine learning plays a role in the future elucidation of its relations. Following the theoretical introduction, I outline each objective and the specific methodologies I will employ to address them.

Narrative Psychology

Human beings are storytellers. We typically share 80-95 percent of everyday and more emotional memories with other people within a day of their occurrence (Pasupathi, Mclean, & Weeks, 2009; see also Rime, 2009, for review). Such a recurrent behavior raises many questions about its functions; why do we so frequently share personal stories and how might this be adaptive? Interestingly, we do not recollect experiences solely for the purpose of accuracy. As Gauld and Stephenson (1967) argue, narrators who "retell a story are unlikely to care very much whether the story they retell is the same, detail by detail, as the story originally heard" (p. 40). There are many reasons other than the provision of accurate information why people share the stories of their lives with others on such a regular basis. For example, one may want to entertain others and create social bonds or convey information to direct their own and others' future behaviors. In doing so, there are multiple functions to sharing personal stories (Bluck et al., 2003; Fivush, 2011; Marsh, 2007). Perhaps some of the most important reasons to share stories

with others are to help individuals make sense of their experiences in order to provide coherence to their lives (Conway, Singer, & Tangini, 2004) and to create an emotionally regulated sense of identity (McAdams, 2008).

When sharing personal stories, Bruner (1987) theorized that people do not just narrate their "landscape of actions" but also their "landscape of consciousness." In other words, people move beyond recollecting a series of actions to retelling a storied subjective experience. The narrative expression of subjective experience includes agents with thoughts, feelings, goals, obstacles, and outcomes. One constructs personal stories filled with such components in order to organize and understand an event as a personal experience. Through narration, we create a subjective understanding and evaluation for events. We make meaning through storying experience.

Making meaning through storying experience appears to come on-line in adolescence (Habermas & Bluck, 2000; Habermas & Reese, 2015). In particular, the increasing cognitive ability and psychosocial motivation to form a healthy adult identity during this period (Erikson, 1968) impels individuals to create a coherent sense of self, from past through present and into the future, through creating a narrative identity (Fivush, Habermas, Waters, Zaman, & 2011; Habermas & Bluck, 2000; McAdams, 2008). Thus, one avenue to create a coherent sense of self is through narratives (McAdams, 2008). Individuals weave past experiences together, connect them to the present, and envision a prospective plan for the future. In particular, one has a sense of the temporal ordering of one's actions, the context of where and when the event took place, and the general theme of the experience (Habermas & Bluck, 2000). Put another way, storying experience directly aids in answering questions: Who am I? What events lead to this? And where am I going as a result of these experiences?

Relations with personality. McAdams (1996, 2008) has laid out the most widely accepted model for narrative expression in the field of personality psychology, coined narrative identity. The model is a framework for personality, in which narrative identity captures individuals' efforts to make meaning in life and understand their selves as individuals. The model specifies five levels to personality: genetics, traits, character adaptations, identity and life story, and culture. Genetics refer to the biological underpinnings to traits. Character traits are defined as stable, dispositional behavioral patterns. Character adaptations include motives, goals, values, developmental concerns (i.e. forming an identity), and other various socio-cognitive pursuits. The primary emphasis of the model is the identity and life story level because it focuses on the subjective meaning in one's life through narrative processing. In McAdams' framework, traits sketch an outline, adaptations fill in details, and stories give rise to meaning. As such, the personality model for narrative identity seeks to investigate narratives for personal themes and intentions because they reflect emerging aspects of personality. However, such a model conflates distinct levels of cognitive processes, such as goals, cognitive ability, social learning, and narrative expression, increasing the need to determine the incremental validity of narratives. Framing narrative processing more directly in the autobiographical memory literature helps elucidate the distinctiveness of the many cognitive processes and helps specify their role in relation to health.

Relations with autobiographical memory. Remembering personal experiences is a dynamic process whereby specific episodic details are flexibly re-constructed in the moment based on personal motivations and goals (Conway & Pleydell-Pearce, 2000). Thus, narrative identity must be related in critical ways to autobiographical memory. Autobiographical memories denote self-referenced memories of personal experience (Fivush, 2011). These

memories are recruited in creating personal narratives (Conway & Pleydell-Pearce, 2000). Moreover, researchers have argued narratives provide organization to goals and motivations, thereby supporting a bi-direction relation (Conway, Singer, & Tangini, 2004). Autobiographical memories are expressed though narratives, and through this expression, the memories themselves may change.

Therefore, a theoretical consequence of autobiographical memory being reconstructive and dynamic is that narratives change over time. Empirically, in addition to individuals' memories obviously fading over time, their retellings of their narratives can be different over time based on changes in their goals and motivations (Conway & Holmes, 2004). Importantly, such memory "biases" are not considered inaccuracies from a functional perspective (see Marsh, 2007, for review). On the one hand, people may stably express personality motivations like achievement. Achievement is defined as the motivation for personal excellence and individuation. Higher achievement motivation is associated with recollection of a greater number of agentic themed memories, as well as narrating these experiences with more agentic language and themes (see Woike, 2008, for review). For example, people high in achievement motivation are more likely to recall the time they won a competition and narrate it in a more intentional, goal oriented manner. On the other hand, people appear to dynamically express their memories based on current states and goals. For example, Wilson and Ross (2002) reviewed studies investigating how people remember their past positive and negative experiences. In particular, they reviewed studies concerning the self-enhancement bias when recalling autobiographical memories. They concluded that more positive memories are typically rated to feel subjectively closer in time to current self than more negative memories. Put another way, more unfavorable

personal events are judged to be "more in the past" or something the "old me" did. As current states and goals change, these evaluations may change as well (Conway et al., 2004).

In summary. Narratives can be viewed from a personality framework and from a cognitive autobiographical memory framework. The cognitive framework, in particular, highlights how narrating the same past event may change over time. Such dynamic processes raise many questions concerning the causal pathways that facilitate health. If people narrate personal experiences to critically organize and better understand events, one would expect changes in narrative organization and understanding to matter for health across time. Thus, one of the major objectives in this research is to examine the extent narrative predicts health across multiple points in time. To facilitate this analysis, I provide further explication of research related to the three objectives: 1) the *incremental validity* of narratives; 2) to examine the possible *longitudinal effect* of narrative on health; and 3) using *machine learning* approaches for specifying extent narrative processing relates to health.

Objective 1 —Incremental Validity of Narratives

There is strong evidence that narrative processing relates to concurrent health. I will examine two aspects of narrative processing that have been identified as critical in both the narrative meaning-making and expressive writing literatures, **coherence** and **growth.**

Coherence. Narrative coherence is defined as how one expresses a past event in a structured and organized manner and is thought to be important because it provides a window into persons' cognitive processes, particularly how they create structure from the complexities and contradictions experiences can bring along. A widely accepted way to operationalize narrative coherence has been along three theoretically and developmentally independent dimensions (Reese, Haden, Baker-Ward, Bauer, Fivush, & Ornstein, 2011): orienting the event

in time and place (context), clearly mapping out the temporal order of actions (chronology), and providing enough detail and elaboration to link the actions, goals, intentions, etc. together into a plausible topic (theme). As traditionally operationally defined above, more coherent narratives are generally related to higher psychological health (Baerger & McAdams, 1999; Waters & Fivush, 2015).

Growth. Narrative growth is defined as the extent individuals integrate the of the impact of the events on selves that matters for specific health outcomes (Adler, Lodi-Smith, Philippe, & Houle, 2016). For example, people who create life lessons (McLean & Pratt, 2006) or increased clarity and refined purpose in life from their experiences (Lilgendahl & McAdams, 2011), demonstrate higher levels of health, even when accounting for their personality traits and demographics (see Adler et al., 2016, for extensive review). The process of embedding one's personal strengths or weaknesses into one's narratives is likely a window to positive self-views and emotional regulation capacities.

Controlling for cognitive factors. Whereas much of the work on incremental validity has been addressed by controlling for basic personality and demographic factors, cognitive factors, in particular, still need further investigation. From a cognitive viewpoint, narrative expression over time theoretically creates an increasingly structured narrative allowing for one's thoughts, feelings, reasoning, and attentional processes to be more flexible. These processes likely implicate working memory and general intelligence, specifically verbal ability. Indeed, verbal ability does relate to some well-being outcomes, such as ego development (McCrae & Costa, 2003). Thus, verbal ability remains an important variable to address in order to examine the assertion the how one narrates an experience uniquely matters for well-being.

Moreover, if and how narrative processing relates to well-being may depend on what type of event is being narrated. Processing positive events, compared to negative events, has little to no effect on well-being (Greenhoot & McLean, 2013; McLean, Breen, & Fournier, 2010; Sales, Merrill, & Fivush, 2013). One reason for the differential relations is that negative experiences pose problems, or disruptions, to one's future plans and overarching life story (McLean, Pasupathi, & Pals, 2007), in addition to the more objective deleterious consequences of the event itself. Narrative processing, then, appears to be an adaptive mechanism to further understand and resolve the disruptive attributes of negative experiences. Positive events pose little to no problem to one's ongoing plans, so there is less need to re-analyze what happened. Thus, one possibility is that people may selectively engage in narrative processing, depending on situations deemed to be disruptive. In order to determine if this is a difference between individuals or types of events for processing challenging experiences, we need to assess the same individuals narrating multiple types of events at multiple time points.

Thus, the study for objective one examines the relation of narrative expressions of integrative meaning and structure to multiple measures of health, over and above personality and cognitive factors. The study utilizes an increasingly popular and validated participant pool, Amazon's Mechanic Turk (Mturk). Mturk is an excellent platform to use for research. Recent studies have found Mturk workers to be a more diverse participant pool and have the same data quality as more traditional participant pools, such as undergraduate students (Buhrmester, Kwang, & Gosling, 2011). In particular, the quality of narratives is comparable across undergraduate populations and Mturk participants (Grysman, 2015). A series of hierarchical multiple regressions will be employed to assess the following hypotheses:

1) if narrative expression is a distinct layer of personality, the present study should replicate findings that narrative growth and coherence add a unique understanding of health levels over and above traits

2) if narrative expression is a distinct cognitive process, the present study should extend the current literature by finding that narrative growth and coherence add a unique understanding of health levels over and above verbal ability and time since event. Narrative expression from negative events should be most indicative of health since both approaches argue that narrative operates as an evaluative emotion-regulation tool for lived experience.

Objective 2—Longitudinal Analysis of Narrative and Well-being

From an autobiographical memory framework, narrative processes are reconstructive. In particular, personal narratives are a dynamic "vehicle" for thoughts, feelings, goals, beliefs, reasoning processing, and the like to come together in a coherent storyline (Bruner, 1991, p. 7). The facts of the past event did not change, but how individuals organized and understood it through narrative processing did. However, narrative and health are rarely studied together beyond one point in time. Whereas we know that there is incremental validity to the relation between narrative and health at a single time point, we do not know these relations have a lasting effect. In Study 2, I again study **coherence** and **growth**, but in this study, I extend the analyses over time. Thus, the central question of this study is whether narrative coherence and growth uniquely and consistently explains health; that is, is narrative a robust indicator of well-being over time?

Adler's two longitudinal studies are the most complex and comprehensive longitudinal narrative studies to date, although both are based on the same dataset of 47 individuals undergoing psychotherapy. For example, Adler (2012) measured agency and coherence in

therapy narratives. He found that agency tended to increase over the course of therapy. Importantly, increases in agency were associated with improved mental health using hierarchical linear modeling (HLM) to explore relations between narrative and mental health across multiple points in time. Adler found that the model that used narratives to explain later well-being was more explanatory than well-being explaining later narratives, thus helping establish directionality of the relationship. Also important in this HLM analysis, these effects remained when controlling for trait neuroticism, ego development, and client and therapist factors. In the same sample, Adler and Hershfield (2012) also found that mixed emotions predicted improvements in the immediately following session, even when controlling for time passed, trait neuroticism, and independent expression of either positive or negative expressions narrated (i.e. separate statements of either happy or sad emotions, but not both). Adler's studies demonstrate the directionality of the relation between narratives and well-being. There appears to be important patterns in narratives that directly related to changes in well-being.

Still, there are limitations to Adler's longitudinal studies, including a small sample size of 47 people and the fact that these are all narratives about psychotherapy, which makes it harder to generalize to other populations and other kinds of narratives. Moreover, across Adler's studies, he did not assess either multiple narrative valences or multiple forms of narrative processing simultaneously in relation to health. It is unclear if one type of narrative or one narrative dimension is more important than the other in relation to health. As such, the assessment of narrative processing as a selective mechanism still remains under examined across all longitudinal narrative studies. Thus, more research needs to be carried out on larger and more diverse samples in order to understand how narratives uniquely relate with health in the current and later moments. In addition, it is important to examine narratives by different emotional

valences. On the one hand, narrative appears to function as an emotion-regulation tool that aids in ameliorating suffering and hardships (Fivush, 2011). On the other hand, narrative also functions as an identity informing tool that utilizes both negative and positive experiences to create an overarching life story (McAdams, 2008). Thus, both negative and positive valenced narratives need to be collected in order to better assess how each relates to health indices.

Thus, the study for objective two investigates if narratives of both negative and positive events are robust indicators of health when examining relations across five points in time alongside personality and cognitive factors, using an extended sample from Study 1. I employ HLM to examine relations between time-varying narratives across time in relation to health.

The hypotheses are threefold:

1) *Higher narrative coherence is expected to robustly relate with measures of health over time, controlling for demographics, personality and cognitive factors. Relations to specific health indicators is more exploratory.*
2) *Higher narrative growth is expected to robustly relate with measures of health over time, controlling for demographics, personality and cognitive factors. Relations to specific health indicators is more exploratory.*
3) *Narrative expression from negative events is expected to be predictive of health, whereas narrative expression from positive events is not expected to carry much explanatory power over time.*

Objective 3—Machine learning in Narrative Analysis

Recent advances in natural language processing allow for the automated analysis of various features of a narrative, primarily its coherence. I will use machine learning approaches for this objective because they offer two major benefits, scalability and new insights. First,

narrative coding of content is labor intensive and time consuming. Developing an automated measure to extract similar aspects of language can allow communities to assess indicators and trajectories of high and low health on a bigger scale in less time. Second, the computational tool developed in the proposed approach will be more transparent, capture more connections because of their unconstrained methods, and thereby discover novel insights in narrative content. Thus, in the third study, I explore implementing a new measure of coherence, sematic coherence, in two, independent samples.

Coherence. As discussed earlier, coherence may be inversely related to stress because coherent narratives provide a basis for organizing a personal event as a platform to reevaluate the semantic conclusions (e.g. from "I am a terrible person" to "I am a survivor") the individual draws from the episodic details of the events (e.g. I got in a terrible car crash). However, such an explanation entails two assumptions that need to be further addressed. First, there might be more ways to assess coherence, above and beyond the general structure of narrative. Whereas hand coded coherence assesses where, when, what, and how something happened, another form of coherence may be reflected in the relative similarity of adjacent sentences in a text—the semantic coherence of personal narrative. Second, there might not be linear relations between forms of narrative coherence and stress over time. More specifically, there might be curvilinear relations of structural coherence and newly developed semantic coherence, demonstrating an optimal level of coherence. Too little semantic coherence may be an indicator of severe mental disorder (Adler, Chin, Kolisetty, & Oltmanns, 2012), and too much semantic coherence might be an indicator of rigidity in functioning (Schwartz, Cote, & Arnett, 2005).

The capability to create automated semantic measures have already been established. In particular, Bedi and colleagues (2015) successfully identified individuals who do or do not go on

to develop schizophrenia using automated methods as well as trained clinicians. They did so by creating a measurement that capitalized on the statistical properties of language usage that measured the semantics of their language, which predicted the onset of schizophrenia with 100 percent accuracy. Individuals that went on to develop schizophrenia had greater semantic distance between their sentences than healthy individuals. The current research goes beyond identifying threshold cases of the presence or absence of severe psychological disorder, since severe disorder has already been consistently linked with lower narrative coherence (Adler; others). The present study aims to examine healthy individuals along a continuum of semantic coherence to explore individual differences in psychological health. Thus, the study utilizes a state of the art semantic space to establish this semantic continuum and, by extension, semantic coherence.

The study for objective two utilizes the Word2vec (W2V) neural network to capture the semantics of language (Mikolov, Sutskever, Chen, Corrado, & Dean, 2013). Broadly, neural networks attempt to mimic brain operations by running a series of algorithms to identify relationships in a large set of data. Instead of predicting the activation of neurons, W2V identifies the relation between target words and their neighboring context words. If word A and B typically have almost identical neighboring words, they are most likely synonyms for each other. Thus, W2V can capitalize on *distributed semantics*, in which similar words tend to occur in similar places. W2V's neural network skip gram algorithm allows for the prediction of neighboring words by using the target word. These predictions are made using vectors spaces, a high dimensional point that is a series of positive point-wise mutual information (PPMI) measurements with other words. For example, running verbs like "run", "sprint", "jog" all tend to have the same PPMI vectors. Mikolov and colleagues have demonstrated how W2V can be

used to start to derive a strong sense of semantics based on how words are distributed together. For example, to obtain the vector space for the word "queen", one can use the vector spaces for "king" - "man" + "woman." W2V is such an exciting tool to use because it can potentially get at the composability of concepts, such as kings and queens, possibly even help derive a level of semantic coherence of personal narratives.

Thus, in addition to measuring the structural components via a hand-coding, the research for objective three entails two studies that also investigate measuring its semantic components via machine learning algorithms that utilize the distributional hypothesis (Firth, 1957). If both measurements are tapping the same underlying construct of coherence, they should be related to some degree—linear or non-linear relations. Thus, hand-coded structural coherence can be used as a ground truth measure to help determine convergent validity for automated semantic coherence. Moreover, once the proof-of-concept semantic coherence measure is made, it should be able to be replicated and extended to measure the extent it relates with psychological health in another sample, as carried out in Study 2. Study 1 aims to create a semantic coherence measure as a proof-of-concept indicator for semantic narrative coherence. In study 2, the curvilinear relation between hand-coded structural and automated semantic coherence was examined in another population. In addition, the extent automated coherence is predictive of important outcomes, well-being, satisfaction with life, stress levels, was also examined. The hypotheses are as follows:

1) *If both measurements are tapping the same underlying construct of coherence, they should be related to some degree—linear or non-linear relations.*
2) *If the relation between semantic coherence and structural coherence is present in one sample of personal narratives, the relation should also be found in another sample of*

the participants' personal narratives.

3) *If these relations are present in one sample of participants, the relation should also be found in entirely different participant pool.*
4) *If the semantics of the narrative matter for psychological health, then it should predict health when structure of the narratives is also in the regression models.*

References

Adler, J. M. (2012) Living into the story: agency and coherence in a longitudinal study of narrative identity development and mental health over the course of psychotherapy. *Journal of Personality and Social Psychology, 102*, 367-389.

Adler, J. M., Chin, E. D., Kolisetty, A. P., & Oltmanns, T. F. (2012). The distinguishing characteristics of narrative identity in adults with features of borderline personality disorder: an empirical investigation. *Journal of personality disorders, 26*, 498-512.

Adler, J. M., & Hershfield, H. E. (2012). Mixed emotional experience is associated with and precedes improvements in psychological well-being. *PLoS One, 7*, e35633.

Adler, J. M., Lodi-Smith, J., Philippe, F. L., & Houle, I. (2016). The Incremental Validity of Narrative Identity in Predicting Well-Being A Review of the Field and Recommendations for the Future. *Personality and Social Psychology Review*, *20*, 142-175.

Baerger, D. R., & McAdams, D. P. (1999). Life story coherence and its relation to psychological well-being. *Narrative Inquiry, 9*, 69-96.

Bedi, G., Carrillo, F., Cecchi, G. A., Slezak, D. F., Sigman, M., Mota, N. B., ... & Corcoran, C. M. (2015). Automated analysis of free speech predicts psychosis onset in high-risk youths. *npj Schizophrenia, 1*, 150-130.

Bluck, S., Alea, N., Habermas, T., & Rubin, D. C. (2005). A tale of three functions: The self–reported uses of autobiographical memory. *Social Cognition, 23*, 91-117.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives on psychological science, 6*, 3-5.

Bruner, J. (1987). Life as narrative. *Social research*, 11-32.

Bruner, J. (1991). The narrative construction of reality. *Critical inquiry*, 1-21.

Conway, M. A., & Holmes, A. (2004). Psychosocial stages and the accessibility of autobiographical memories across the life cycle. *Journal of Personality, 72*(3), 461-480.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review, 107*, 261-288.

Conway, M. A., Singer, J. A., & Tagini, A. (2004). The self and autobiographical memory: Correspondence and coherence. *Social cognition, 22*(5: Special issue), 491-529.

Eichstaedt, J. C., Schwartz, H. A., Kern, M. L., Park, G., Labarthe, D. R., Merchant, R. M., ... & Weeg, C. (2015). Psychological language on Twitter predicts county-level heart disease mortality. *Psychological science, 26*, 159-169.

Firth, J. R. 1957. A synopsis of linguistic theory 1930-1955. *Studies in linguistic analysis*, 51: 1-31.

Fivush, R. (2011). The development of autobiographical memory. *Annu Rev Psychol, 62*, 559-582.

Fivush, R., Habermas, T., Waters, T. E., & Zaman, W. (2011). The making of autobiographical memory: Intersections of culture, narratives and identity. *International Journal of Psychology, 46*, 321-345.

Gauld, A., & Stephenson, G. M. (1967). Some experiments relating to Bartlett's theory of remembering. *British Journal of Psychology, 58*, 39-49.

Graci, M. E., Watts, A. L., & Fivush, R. (2018). Examining the factor structure of narrative meaning-making for stressful events and relations with psychological distress. *Memory*, 1-13.

Greenhoot, A. F., & McLean, K. C. (2013). Introduction to this Special Issue Meaning in personal memories: Is more always better?. *Memory, 21*, 2-9.

Grysman, A. (2015). Collecting narrative data on Amazon's Mechanical Turk. *Applied Cognitive Psychology, 29*, 573-583.

Habermas, T., & Bluck, S. (2000). Getting a life: the emergence of the life story in adolescence. *Psychological bulletin, 126*, 748.

Habermas, T., & Reese, E. (2015). Getting a life takes time: The development of the life story in adolescence, its precursors and consequences. *Human Development, 58*, 172-201.

Klein, K., & Boals, A. (2001). Expressive writing can increase working memory capacity. *Journal of Experimental Psychology: General, 130*, 520.

Lilgendahl, J. P., & McAdams, D. P. (2011). Constructing stories of self-growth: How individual differences in patterns of autobiographical reasoning relate to well-being in midlife. *Journal of Personality, 79*, 391-428.

Marsh, E. J. (2007). Retelling Is Not the Same as Recalling Implications for Memory. *Current Directions in Psychological Science, 16*, 16-20.

McAdams, D. P. (1996). Personality, modernity, and the storied self: A contemporary framework for studying persons. *Psychological inquiry, 7*, 295-321.

McAdams, D. P. (2008). Personal narratives and the life story. *Handbook of personality: Theory and research, 3*, 242-262.

McCrae, R. R., & Costa, P. T. (2003). *Personality in adulthood :A five-factor theory perspective*. New York, NY: Guilford Press.

McLean, K. C., Breen, A. V., & Fournier, M. A. (2010). Constructing the Self in Early, Middle, and Late Adolescent Boys: Narrative Identity, Individuation, and Well-Being. *Journal of Research on Adolescence*, *20*, 166-187.

McLean, K. C., Pasupathi, M., & Pals, J. L. (2007). Selves creating stories creating selves: a process model of self-development. *Pers Soc Psychol Rev, 11*, 262-278.

McLean, K. C., & Pratt, M. W. (2006). Life's little (and big) lessons: identity statuses and meaning-making in the turning point narratives of emerging adults. *Developmental psychology*, *42*, 714.

Mikolov, T. Sutskever, I. Chen, K. Corrado, G. & Dean, J. (2013). Distributed representations of words and phrases and their compositionality. *Advances in neural information processing systems, 26*, 1081-1088.

Pasupathi, M., McLean, K. C., & Weeks, T. (2009). To tell or not to tell: Disclosure and the narrative self. *Journal of Personality*, *77*, 89-124.

Reese, E., Haden, C. A., Baker-Ward, L., Bauer, P., Fivush, R., & Ornstein, P. A. (2011). Coherence of personal narratives across the lifespan: A multidimensional model and coding method. *Journal of Cognition and Development, 12*, 424-462.

Rimé, B. (2009). Emotion elicits the social sharing of emotion: Theory and empirical review. *Emotion Review*, *1*, 60-85.

Sales, J. M., Merrill, N. A., & Fivush, R. (2013). Does making meaning make it better? Narrative meaning making and well-being in at-risk African-American adolescent females. *Memory*, *21*, 97-110.

Schwartz, S. J., Côté, J. E., & Arnett, J. J. (2005). Identity and agency in emerging adulthood two developmental routes in the individualization process. *Youth & Society*, *37*, 201-229.

Schwartz, H. Andrew, Johannes C. Eichstaedt, Margaret L. Kern, Lukasz Dziurzynski, Stephanie M. Ramones, Megha Agrawal, Achal Shah et al. "Personality, gender, and age in the

language of social media: The open-vocabulary approach." *PloS one* 8, no. 9 (2013): e73791.

Schwartz, H. A., Eichstaedt, J., Kern, M. L., Park, G., Sap, M., Stillwell, D., ... & Ungar, L. (2014). Towards assessing changes in degree of depression through facebook. In *Proceedings of the Workshop on Computational Linguistics and Clinical Psychology: From Linguistic Signal to Clinical Reality* (pp. 118-125).

Waters, T. E., & Fivush, R. (2015). Relations between narrative coherence, identity, and psychological well-being in emerging adulthood. *Journal of personality*, *83*, 441-451.

Wilson, A. E., & Ross, M. (2003). The identity function of autobiographical memory: Time is on our side. *Memory, 11*, 137-149.

Woike, B. A. (2008). A functional framework for the influence of implicit and explicit motives on autobiographical memory. *Personality and Social Psychology Review, 12*, 99-117.

The Uniqueness of Narrative Expression in Predicting Health: Accounting for Traits and Verbal Ability

Matthew E. Graci

Emory University

Abstract

This study investigated the uniqueness of narrative expression in relation to multiple health indices while considering personality and cognitive factors. Three-hundred participants from an online community sample (m_{age} = 24.39, Age_{range} = 18-29; 60% self-identified as women; 100% US residents) wrote about the most negative and positive times in their life, and completed a series of psychological questionnaires. The narratives were coded for coherence and growth. A series of hierarchical multiple regressions revealed that narrative coherence and growth, primarily from positive events, related to multiple forms of health (e.g., well-being, perceived stress) over and above verbal ability and personality traits. Individuals with more advanced verbal skills are not simply better storytellers with greater levels of health. In addition to personality and cognitive skillsets, *how* personal stories are retold remain crucial to understanding persons' health.

The Uniqueness of Narrative Expression in Predicting Health: Accounting for Traits and Verbal Ability

The narrative qualities of people's personal stories communicate underlying aspects of their health. Narrators who share their personal stories with a higher level of structure (e.g., give stories a theme, context, and sense of chronology) and meaning (e.g., express growing from experience) demonstrate a greater sense of health, as measured by a multitude of indices (e.g., higher psychological well-being, lower stress; Adler, Lodi-Smith, Phillippe, & Houle, 2016). Storying experience in a structured manner theoretically allows narrators to process their thoughts and feelings in ways that help allow them to create meaning and reap health benefits from the event (Fivush, 2011). However, many personality and cognitive factors are involved in the storying of personal narratives. Personality and cognitive factors are also related to health, raising concerns about specifying the unique relation between narrative expression and health. Do the ways people express their stories relate to health indices in ways not predicted by their personality traits and cognitive abilities? Is narrative expression of personal experience a unique window into health, including psychological well-being, life satisfaction, perceived stress, and physical health?

Depending on the sub-discipline in psychology, researchers address the problem of narrative specification using different approaches. Personality researchers, for example, focus on specifying characteristics of *selves* constructing their stories; their research reveals that more trait-neurotic people tell more anxious stories (Baddeley & Singer, 2008). Cognitive researchers, on the other hand, tend to focus on specifying characteristics of the *events* involved in constructing personal stories. For example, individuals' perceived emotional intensity of negative events fades more quickly than perceived intensity of positive events (Walker,

Skowronski, & Thompson, 2003). Both personality and cognitive factors most likely work in synchrony in creating narrative expressions, as selves experience events in complex, ongoing lives. Yet studying personal stories from both of these approaches is rarely done, making it difficult to determine how specific qualities of narrative expression uniquely relate to health over and above narrators' construction of *selves* and *events*. Thus, to better understand how storying personal experience uniquely conveys underlying aspects of health, the present study examines how people create meaning and structure in their narratives when considering their personality factors and their cognitive factors.

Personality Approaches

Selves creating stories is a longstanding investigation into personality (McLean, Pasupathi & Pals, 2007), as narrative is conceptualized as a layer of personality. McAdams (1996) has laid out the most widely accepted model for narrative expression in the field of personality psychology. Collectively the model entails five levels to personality: genetics, personality traits, character adaptations, identity and life story, and culture. Genetics refer to the biological underpinnings to traits. Character traits are defined as stable, dispositional behavioral patterns. Character adaptations include motives, goals, values, developmental concerns (i.e., forming an identity), and other various socio-cognitive pursuits. Identity and life story is the primary emphasis of this model, because it focuses on the subjective meaning in one's life through storying their personal experiences. Individuals do not just express experience through their narratives; they make meaning in life and understand their selves as individuals through narratives.

The ways in which people make meaning from their experiences affect their levels of health. People who narrate their experiences redemptively—turning a highly negative event into

a positive one—demonstrate a number of cognitive-affective and behavioral benefits (McAdams, Reynolds, Lewis, Patten, & Bowman, 2001). In particular, more redemptive narrators show improved psychological health after a serious injury (Adler et al., 2015) and are more likely to stay in recovery from alcoholism (Dunlop & Tracy, 2013) compared to people who do not narrate redemptively. Such meaning-making theoretically taps a level of growth from persons' experiences.

Narrative growth in particular is a critical component to understanding how narratives relate to health, because it captures how people express describe, resolve, and develop as individuals following highly emotional experiences. Narrative growth entails integrative meaning of the impact of the events on selves that matters for specific health outcomes (Adler et al., 2016). For example, people who create life lessons (McLean & Pratt, 2006) or increased clarity and refined purpose in life from their experiences (Lilgendahl & McAdams, 2011), demonstrate higher levels of health, even when accounting for their personality traits and demographics (see Adler et al., 2016, for extensive review). In particular, embedding the impact on the self in the narrative of the event is related to emotion regulation strategies (i.e., absence of rumination, presence of positive reappraisal; Cox & McAdams, 2014) and ego development (i.e., personal maturation), but not general life satisfaction (King, Scollon, Ramsey, & Williams, 2000). The process of embedding one's personal strengths or weaknesses into one's narratives is likely a window to positive self-views and emotional regulation capacities, but not necessarily one's level of general satisfaction with life.

Importantly, however, the personality approach model conflates distinct levels of cognitive processes. One can still wonder how the cognitive characteristics of personal events affect the selves processing them. How might the characteristics of events and one's cognitive

ability to verbally construct these events explain narrative expression? The present study's central question addresses the unique relation between narrative expression and health when considering both personality *and* cognitive factors.

Cognitive Approaches

Individuals' personal stories help them both evaluate and organize their personal experiences. When sharing personal stories, Bruner (1987) theorizes that people do not just narrate their "landscape of actions," they also narrate their "landscape of consciousness." In other words, people move beyond recollecting a series of actions to retelling a storied subjective experience – individuals do not just express narratives, they make meaning from events through the active construction of personal narratives. Such construction of experience is a multifaceted process; there are both characteristics of events, as well as characteristics of individuals, that critically inform people's personal narratives. Studying these cognitive factors in relation to narrative expression can further elucidate how personal narratives matter for health.

Telling distressing events might be more important for good health than telling other kinds of events. Frattaroli's (2006) meta-analysis of 146 studies demonstrates consistent small to moderate effects on both psychological and physical health as a result of engaging in expressive writing of various real and/or fictional distressing events. Simply listing negative emotions or writing about superficial topics (Pennebaker, 1997) is not as effective at reducing stress as is expressive narrative writing about stressful experiences (Smyth, True, & Souto, 2001). In addition, writing about positive experiences does not facilitate increases in well-being (Lyubomirsky, Sousa, & Dickerhoof, 2006). When concurrently analyzing multiple kinds of events–high points, low points, turning points, and greatest health challenges–narrative expression from low points and health challenges, but not high points and turning points, were

predictive of physical and mental health. Thus, the evaluative process of narrative expression might be more important for negative experiences than positive experiences for understanding individuals' level of health.

The amount of time since the occurrence of events also affects the way personal stories are narrated. Shortly after events, personal narratives typically increase in cognitive processing words (e.g., "understand," "realize"), suggesting an increase in thematic coherence, as well an increase in causal temporal words (e.g., "because,'' ''before,'' ''after''), suggesting an increase in context and chronological coherence (see Pennebaker & Chung, 2011, for a full review). These changes demonstrate that individuals attempt to evaluate and create structure shortly after events. Years after events, individuals convey fewer details when recalling these memories, partly due to basic forgetting functions (Rubin & Wenzel, 1996). When accounting for time since the events, narrative expressions can sometimes be less indicative of individuals' psychological health and more indicative of the basic memory processes that occur over time (see Waters, Bohanek, Marin, & Fivush, 2013, for arguments).

In addition to characteristics of the events, narrators' broader cognitive abilities—particularly verbal ability—likely matter for good health. Individuals' intelligence quotient (IQ) relates to an array of positive outcomes, in part because people with higher IQ's also possess elevated reasoning, problem-solving, and learning abilities (Gottfredson & Deary, 2004). Perhaps people with higher IQ's possess both more developed storytelling skills and higher levels of health, though such a claim is more widely studied in children than adults. Children with higher verbal abilities engage in more elaborate conversations with their mothers, at least below the age of 3 (Farrant & Reese, 2000; Newcombe & Reese, 2004), and research reveals that more elaborate maternal conversations relate to better verbal memory (Tessler & Nelson, 1994)

and also greater emotional understanding (Laible, 2004), with fewer externalizing behaviors (i.e., an indicator for healthy living; Laible, Carlo, Torquati, Ontai, 2004). Because verbal ability is rarely studied in adults beyond blunt demographic information (i.e., education level), a cognitive level of analysis needs to be performed in order to better specify if and how individuals' narrative expressions uniquely relate with health, in addition to a trait level analysis of narrators. The type and timing of narrative retellings, as well as individuals' verbal ability to tell their personal stories, are critically implicated in the narrative construction of events.

Present Study

The present study examines the relation of narrative expressions of integrative meaning and structure to multiple measures of health, over and above personality and cognitive factors. Narrative integrative meaning will be assessed via growth (Lilgendahl & McAdams, 2011)—the extent to which one expresses using personal events as catalysts for personal growth, maturation, and/or insights. Narrative structure will be assessed via coherence (Reese, Haden, Baker-Ward, Bauer, Fivush, & Ornstein, 2011)—the extent to which one places one's experience in a clear context, chronology, and an elaborated theme. As these narrative dimensions have been shown to differentially relate to measures of health over and above traits (Graci, Watts, & Fivush, 2018), the present study includes multiple forms of health, measuring positive well-being, negative well-being, and physical health.

The present study also utilizes an increasingly popular and validated participant pool, Amazon's Mechanic Turk (Mturk). Mturk is an excellent platform to use for research. Recent studies have found Mturk workers to be a more diverse participant pool and have the same data quality as more traditional participant pools, such as undergraduate students (Buhrmester,

Kwang, & Gosling, 2011). In particular, the quality of narratives is comparable across undergraduate populations and Mturk participants (Grysman, 2015).

The hypotheses are twofold: 1) if narrative expression is a distinct layer of personality, the present study should replicate findings that narrative growth and coherence add a unique understanding of health levels over and above traits; and 2) if narrative expression is a distinct cognitive process, the present study should extend the current literature by finding that narrative growth and coherence add a unique understanding of health levels over and above verbal ability and time since event. Narrative expression from negative events should be most indicative of health since both approaches argue that narrative operates as an evaluative emotion-regulation tool to lived experience.

Method

Data were collected as part of a parent longitudinal data collection examining how people narrate highly emotional experiences over time. The present study utilizes the data from all 300 participants in the first time-point of data collection. At this time-point, participants were assessed on their personality and cognitive factors, in addition to writing narratives and being assessed on their levels of health. The following four time-points only prompted participants to write narratives and fill out the health questionnaires. Thus, the present study's aim to better specify narrative expression in relation to health over and above personality and cognitive factors is best suited using time-point one data.

In total, 300 people participated in the study (m_{age} = 24.39, range from 18 to 29; 60% self-identified as women). Participants had a fairly even distribution of educational background, with the majority of participants reporting a college degree (36%) or some college education (32%). Sectioned off by 2016 IRS tax brackets, participants also had a fairly even distribution of

economic backgrounds, as the majority of the participants reported a salary of $9,276-37,650 (42%) or others who made $0-9,275 (30%). The participants self-identified as predominately Caucasian (67%). Please see Table 1 for a full breakdown of demographics.

Procedure

Participants received $1 for participation in this time-point of data collection, and all procedures were approved by the university's Institutional Review Board. Data were collected using Amazon's Mechanical Turk (Mturk) platform via TurkPrime, which automated parts of the data collection process (Litman, Robinson, & Abberbock, 2016) . The participants were provided 90 minutes to complete to entire survey. On average, participants took 39.48 minutes (±18.26 minutes) to complete the study. The study consisted of filling out a series of demographics, health measures, counter-balanced negative and positive narrative prompts, and then a series of individual difference surveys and tasks.

Inclusion Criteria. There were several requirements for Mturk workers to participate in the study. Participants had to live in the United States (verified by an I.P. address checker), be a native English speaker, and 18-30 years old. In addition, another suggested inclusionary criteria on Mturk is to only allow participants that have a 90 rating or above on Mturk (e.g., workers that do not complete tasks/studies garner lower ratings) and a history of participation in over 100 others tasks/studies overall, in order to help ensure stronger data quality (Peer, Vosgerau, & Acquisti, 2014).

Exclusion Criteria. Participants had to be excluded from the study when their data quality was demonstrably poor. Two instructional attention checking questions (Oppenheimer, Meyvis, & Davidenko, 2009) were included in the data collection (e.g., "please select agree for this question"). Participants were excluded from the participant pool when they failed both attention

checking questions and completed the study under 1.5 standard deviations below the average time of completion (i.e. in approx. 5 or less minutes), or verifiably copied and pasted their narratives from an internet source via google search (e.g., submitted video game reviews instead of personal narratives). In total, 19 Mturk of the total 319 workers surveyed were excluded from the dataset because of these criteria, but were still compensated for their time. Again, demographic description of the final pool of 300 participants is presented in Table 1.

Narrative prompt. The negative and positive narrative writing prompts was adopted from the expressive writing literature (Pennebaker, 1997):

> For the next 10 to 15 minutes, please write about the most negative [positive] experience of your life. This should be an extremely emotional event that has affected you and your life. Please include the facts of the event, as well as your deepest thoughts and feelings. All of your writing will be kept confidential. Do not worry about spelling, sentence structure, or grammar, but please keep writing for 10 to 15 minutes.

The order of completion of tasks was as follows: basic demographics, the four health surveys, the counter-balanced narrative prompts, personality traits, and then verbal ability. The counter balancing of narrative prompts was performed using *Qualtrics* counter-balancing functionality, in which the platform randomly presents the negative narrative prompt first 50% of the time across the sample.

Narrative Coding

Narratives were coded for coherence along three dimensions, as outlined by Reese and colleagues (2011): coherence: theme, context, and chronology, and for growth (Lilgendahl & McAdams, 2011). As stated in the introduction, coherence taps the underlying structure of personal narratives, whereas the growth taps the underlying integrative processing of personal

narratives. Please see Table 2 for more details on the coding schemes, as well as the basic statistics for each dimension. See also Appendix A for examples for scoring the narratives.

Each narrative indicator was coded by two to three independent coders. Whereas the specific coders were different for some narrative indicators, the training and reliability procedure was the same. For each narrative indicator, all coders learned the specific coding scheme through reading and discussion of that coding manual. Then, the coders used a predetermined set of the narratives during the coding training phase. During this phase, the coders discussed each narrative code in depth. After training, a previously unexamined subset of narratives (approximately 60 narratives) was coded independently by each coder in order to compute reliability. Once reliability was established, the two coders scored the rest of the dataset, including recoding the narratives used during the training phase. To check for coding drift, two additional subsets of 20 narratives were independently coded by both coders approximately 50% and 75% through coding each scheme. Thus, a total of 100 narratives constitutes the reliability statistics shown to the rightmost column in Table 2.

Health Measures

The study relied on four indicators of health in order to tap theoretically different aspects of psychological health (Ryan & Deci, 2001). The measures tapped both psychological and physical health, as detailed below.

Life Satisfaction was assessed using the *Satisfaction with Life Scale* (Diener, Emmons, Larsen, & Griffin, 1985), which comprises 5-items rated on a 7-point scale (1= *Strongly disagree* and 7 = *Strongly agree*). For example, “The conditions of my life are excellent.” Negatively worded items were reverse coded, and then all items were summed together for a composite

score. Thus, higher scores represent greater satisfaction with life. Reliability on this scale was strong for this sample (α = .90).

Psychological well-being was assessed using the *Brief Personal Well-being Scale, short form* (Ryff, 1989), which comprises 18-items rated on a 6-point scale (1= *Strongly disagree* and 6 = *Strongly agree*). For example, "I have confidence in my opinions, even if they are contrary to the general consensus." Based on empirical recommendations to bolster reliability, the six subscales (i.e., Positive relations, Autonomy, Environmental mastery, Purpose in Life, Personal Growth) were summed together for one composite measure (Kafka & Kozma, 2002). Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent higher rated psychological well-being. Reliability on this scale was strong for this sample (α =.86).

Stress was assessed using the *Perceived Stress Scale* (Cohen, Kamarck, & Mermelstein, 1994), which comprises 10-items rated on a 5-point scale (0 = *Never* and 4 = *Very Often*). For example, "In the last month, how often have you been upset because of something that happened unexpectedly?" Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent higher rated stress. Reliability on this scale was strong for this sample (α = .89).

Physical health was assessed using the *SF-12 form* (Ware, Kosinski, & Keller, 1995), which comprises 12-items, varying in scale. For the purposes of this study, we did not score the six mental health items. Thus, only the four domains of physical health (i.e., physical function, role physical, bodily pain, general health) were scored. For example, "During the past week, how much did pain interfere with your normal work (including work outside the home and housework)?" Negatively worded items were reverse coded, and then all items were summed

together. Thus, higher scores represent higher rated physical health. Reliability on this scale was acceptable for this sample (α = .76).

Individual Difference Measures

Personality traits were assessed using the *NEO Five Factor Inventory* (Costa & McCrae, 1992), a widely-used and well-validated general personality measure, which consists of 60 items discerning stable dispositions along five dimensions: Extraversion, Neuroticism, Agreeableness, Conscientiousness, and Openness to Experience. Each item was assessed on a 5-point scale (0 = *strongly disagree* and 4 = *strongly agree*) and within-dimension items were summed. Reliability for all traits was strong for this sample for this sample (α =.81; .88; .78; .88; .80, respectively)

Verbal ability was assessed using the Air Force Officer Qualifying Test, as it is an indicator of fluid intelligence (Unsworth, 2010). The verbal analogies task entails reading incomplete analogies and selecting one out of five possible words that best completed the analogies. The participants were provided one practice item, and then were provided 5 minutes to complete 18 test items. An example item is "EXCITEMENT is to BOREDOM as PASSION is to: A) Nostalgia; B) Ignorance; C) Fatigue; D) Interest; *E) Indifference*." These items were drawn from the air force officer qualifying test (AFOQT; Berger, Gupta, Berger, & Skinner, 1990), and pulled from the same subset as Kane, Hambrick, Tuholski, Wilhelm, Payne, and Engle (2004). The participants' total correct responses were summed together. Thus, higher scores represent higher verbal ability. Reliability for verbal ability was acceptable for this sample (α = .78).

Data Analytic Plan

The data analytic plan entails basic descriptives on all variables, analyses on zero-order correlations between all measures, and then performing a series of hierarchical multiple

regressions to help assess the predictive value of narrative indicators over and above personality and cognitive factors. Personality (models 1–4) and cognitive factors (models 5–8) are entered as the first block of separate regressions models, and then narrative indicators were entered in the second block for regressions, in order to more clearly specific the role of narrative in relation to health. When preliminary analyses revealed relations with health, the significantly related variables were also added in block 1 of all regression models.

Results

Narrative Topics

The majority of the narrated *negative* memories concerned interpersonal conflicts (37.33%), followed by death or loss (21.33%), serious illness or injury (17.33%), physical or sexual abuse (12.33%), failures or personal shame (3.33%), or another undefinable category (8.33%). The average time spent writing negative narratives was 8.59 minutes (± 6.41 minutes).

The majority of the narrated *positive* memories concerned interpersonal relations (50.00%), followed by achievements (29.67%), self-improvement (13%), another undefinable category 13.00%). The average time spent writing positive narratives was 8.19 minutes (± 5.83 minutes).

Preliminary Analyses

For descriptives on all narrative and health measures, please see Table 3, and Table 4 for a correlation matrix among all variables. There are small to medium effects between narrative, personality, and cognitive predictors. As expected, there are many relations between traits and verbal ability with narrative, which are highly intercorrelated with the narrative indicators. Also, as expected, the health measures are highly intercorrelated with each other, ranging from .47 to .61 in effect size. Moreover, there are basic correlations between narratives and health as well as

medium relations between narratives with trait neuroticism, and verbal ability. See table 5 for all correlations between health measures and covariates.

Income level had small and consistent relations with all four dimensions of health indices measures. Other covariates, like higher education and longer time since the negative event, revealed positive relations with well-being and life satisfaction. In addition, engagement in the task, measured as minutes spent writing, related positively with well-being for both time spent writing the negative and positive narratives. Please see Table 6 for more details. Given the small, but consistent relations between most covariates and demographics, we include gender, income, and education level in regression models.

Regression diagnostics. All of the following regressions were checked for the assumptions of normality, homoscedasticity, collinearity, and nonlinearity, none of which were violated. Autocorrelations and outliers were also assessed. As a sensitivity check, regressions were run with and without outliers in the dataset, as identified using the Bonferroni Outlier Test in R, to observe the consistency of results. In these sensitivity analyses, the few outliers were not removed from final analyses because zero changes were observed in the findings.

Personality factors

Four regression models were run, one on each health measure. Although the health measures were highly intercorrelated, another aim to the present study was to determine whether there would be different patterns of relations with personality and narrative variables.

Personal Well-being (1). The regression model on personality traits, demographics, and narrative indicators explained 68.1% in personal well-being. Narrative indicators were significant predictors of well-being above and beyond personality traits and demographics: $\Delta R^2 = .026$, $\Delta F(4, 265) = 5.345$, $p < .001$. All five traits related with well-being, with Neuroticism ($\beta =$

-.395, t = -8.562, p < .001), and Conscientiousness (β = .323, t = 7.257, p < .001) having the largest effect sizes. In terms of demographics, women were more likely to have higher sense of well-being than men (β = .093, t = 2.539, p = .012). In terms of narrative indicators, higher coherence from positive events was the only significant predictor for higher well-being (β = .130, t = 3.080, p = .002). See Table 7 for more details.

Satisfaction with life (2). Personality traits, demographics, and narrative indicators explained 36.1% in life satisfaction. Narrative indicators were not significant predictors of life satisfaction above and beyond personality traits: ΔR^2 = .008, $\Delta F(4, 266) = 0.821$, p < .513. Three traits predicted higher life satisfaction, lower neuroticism (β = -.375, t = -5.662, p < .001), higher extraversion (β = .122, t = 2.12, p = .045), and higher conscientiousness (β = .171, t = 2.714, p = .007), but no basic demographics or narrative indicators were significant predictors of life satisfaction. See Table 7 for more details.

Stress (3). Personality traits, demographics, and narrative indicators explained 57.2% in stress. When all narrative indicators were simultaneously added to the model, it did not result in greater model improvement above and beyond personality traits: ΔR^2 = .008, $\Delta F(4, 264) = 1.269$, p < .283), but one narrative indicator, more growth from positive events, related with lower stress (β = -.095, t = -2.231, p = .026). Two traits predicted higher stress, higher neuroticism (β = .686, t = 12.787, p < .001) and lower conscientiousness (β = -.107, t = -2.069, p = .040), but there were no basic demographics that predicted stress. See Table 7 for more details.

Physical Health (4). Personality traits, demographics, and narrative indicators explained 36.1% in physical health. Narrative indicators were not significant predictors of physical health above and beyond personality traits: ΔR^2 = .011, $\Delta F(4, 276) = 1.039$, p < .388. Lower neuroticism (β = -.317, t = -4.560, p < .001) and higher conscientiousness (β = .173, t = 2.587, p

= .010) were significant predictors, but no basic demographics or narrative indicators were significant predictors of higher physical health. See Table 7 for more details.

Thus, it appears that trait neuroticism is a robust predictor of negative health, whereas trait conscientiousness was a small but consistent predictor of positive health. Higher narrative structure to narrators' most positively narrated events relates with higher well-being after controlling for traits and demographics. Higher narrative growth to narrators' most positive events relates with lower stress levels.

Cognitive Factors

Four regression models were run with cognitive factors now in block one of the regressions, one model on each health measure.

Well-being (5). Cognitive factors, demographics, and narrative indicators explained 19.8% of the variance in wellbeing. Narrative indicators were significant predictors of well-being above and beyond cognitive factors: $\Delta R^2 = .027$, $\Delta F(4, 276) = 4.198$, $p = .003$. Higher verbal ability ($\beta = .171$, $t = 2.625$, $p = .009$) related with higher well-being. In terms of demographics, income ($\beta = .213$, $t = 3.837$, $p < .001$) and gender ($\beta = .137$, $t = 2.482$, $p = .014$) were also positive predictors. In terms of narrative indicators, higher growth from negative events related with higher well-being ($\beta = .133$, $t = 2.419$, $p = .016$). See Table 8 for more details.

Life Satisfaction (6). Cognitive factors, demographics, and narrative indicators explained 10.9% of the variance in life satisfaction. Narrative indicators were not significant predictors of life satisfaction above and beyond cognitive factors: $\Delta R^2 = .027$, $\Delta F(4, 276) = 2.076$, $p = .084$. Only higher income ($\beta = .170$, $t = 2.902$, $p = .004$) and lesser time since positive event ($\beta = -.133$, $t = 2.201$, $p = .029$) related with higher life satisfaction. See Table 8 for more details.

Stress (7). Cognitive factors, demographics, and narrative indicators explained 10.6% of the variance in stress levels. Narrative indicators were significant predictors of stress levels above and beyond cognitive factors: $\Delta R^2 = .041$, $\Delta F(4, 274) = 3.154$, $p = .015$. In terms of cognitive factors, less time since positive event ($\beta = -.130$, $t = 2.173$, $p = .031$) related with higher life satisfaction. In terms of demographics, higher income related with lower stress ($\beta = -.135$, $t = 2.283$, $p = .023$). Lower narrative growth in both the negative ($\beta = -.116$, $t = 1.999$, $p = .047$) and positive experiences ($\beta = -.162$, $t = 2.716$, $p = .007$) related with higher levels of stress. See Table 8 for more details.

Physical Health (8). Cognitive factors, demographics, and narrative indicators explained 8.9% of the variance in physical health. When all narrative indicators were simultaneously added to the model, it did not result in greater model improvement above and beyond cognitive factors: $\Delta R^2 = .020$, $\Delta F(4, 277) = 1.545$, $p = .189$, but one narrative indicator, narrative growth from negative experiences, related with higher levels of physical health ($\beta = .138$, $t = 2.372$, $p = .018$). No cognitive factors related with physical health. Higher income was again related with physical health ($\beta = .178$, $t = 2.283$, $p = .023$). See Table 8 for more details.

Thus, it appears growth from the most negative event in narrators' lives was related to more positive health indices. Income was also a significant predictor of health, while verbal ability carried very little predictive power.

Of note, when combining both personality, cognitive factors and demographics all as covariates in the regression models, coherence from positive events still predicts higher well-being ($\beta = .111$, $t = 2.530$, $p = .012$); and lower growth from positive events relates to higher stress ($\beta = -.107$, $t = 2.527$, $p = .012$); but growth from negative events loses predictive power for stress ($\beta = .063$, $t = 1.158$, $p = .248$).

Discussion

The manner in which people narrate their personal stories is uniquely indicative of well-being, even when considering the event characteristics and the individuals narrating them. There are relations between narrative meaning-making and trait-like measures, including verbal ability and personality, but each appear to be distinct processes. Importantly, individuals who possess superior verbal ability or certain personality traits are not necessarily the healthier narrators. Narrative coherence and growth appear to be distinct forms of narrative meaning-making that uniquely and differentially predict well-being and stress levels, respectively.

Perhaps the most meaningful finding in this study—given how little already exists in the literature—is the minimal relation between verbal ability and narrative meaning-making. It is widely assumed that people with superior language ability generally make for better narrators. However, only one study has actually examined this and found that narrative expression is uniquely related to health when accounting for verbal SAT scores and educational attainment (Lilgendahl, Helson, & John, 2013). Our research replicates and expands this finding by using a more direct measure of verbal ability to again find that narrative expressions predict health indices when controlling for verbal ability. Whereas verbal ability does predict how coherently or growth-oriented individuals narrate their personal experiences, verbal ability does not predict health indices. Individuals with advanced verbal skill do not automatically express healthier forms of structure and growth orientation in their personal stories.

Even so, people's personality traits, narrative expression, and level of health are strongly associated with each other. Increased trait neuroticism (i.e., emotional instability) and decreased trait conscientiousness (i.e., impulsiveness), in particular, are robust predictors of poorer health. Other research has also indicated that neuroticism and conscientiousness influence how people

react to emotions and stimuli more broadly. In particular, higher neuroticism and lower conscientiousness are associated with chronic over-activation of the autonomic nervous system (Graham, Christian, & Kiecolt-Glaser, 2006), which influences health levels (see Friedman & Kern, 2014, for review). Perhaps unsurprisingly, the results here demonstrated significant overlap between traits and narrative expressions in explaining health; more conscientious people wrote more coherent narratives, as did more trait-agreeable and trait-open people. People with lower neuroticism, higher extraversion, or higher conscientiousness demonstrated more growth in narrating negative experiences, but participants' traits did not relate with any growth expression for positive experiences.

Even given these associations between traits and narratives, narrative meaning-making is still uniquely indicative of well-being and stress. In particular, higher coherence in narrating positive events relates to higher well-being, and higher growth in narrating positive events relates to lower stress—when controlling for traits, gender, income, and education level. The findings support two broad ideas in the literature. First, narratives are uniquely indicative of health when considering traits (Adler et al., 2016). Second, narrative expression is not a unimodal predictor of health; there are differential relations between forms of narrative meaning-making with indices of health (Graci et al., 2018). Consistent with previous findings, coherence in narrating positive events relates to well-being, as found in other studies (Waters & Fivush, 2015), and growth from positive events relates with lower stress (Cox & McAdams, 2014). When controlling for personality traits, having greater structure (i.e., coherence) to personal narratives is indicative of personal well-being, while having greater integrative meaning (i.e., growth) to personal narratives was indicative of emotion-related regulation levels.

These findings further support the notion of an underlying framework to narrative expression. Theoretical (Adler et al., 2016) and empirical accounts (Graci et al., 2016) of narrative meaning-making support the idea that more than one form of narrative meaning-making exists: there are structural components to narrative meaning-making (i.e. coherence), integrative meaning components (i.e., growth), as well as more valanced emotional processing components (e.g., positive and negative narrative expression). Given the very few correlations between narrative coherence and growth measures, as well as the differential relations with health indices, this study replicates findings that narrative structure and integrative processing are different types of narrative meaning-making. Narrative expression is comprised of multiple facets, each of which uniquely indicate levels of health.

Accounting for personality and cognitive factors separately helps better approximate the unique relation between narrative and health. For example, it appears that traits have more predictive overlap in explaining how narrators might inject meaning into their stories, whereas verbal ability has more predictive overlap in explaining how narrators structure their stories. These findings align with how narratives are conceptualized within each sub-discipline. The personality approach views narrative as a tool for subjective meaning-making, and the findings from this study demonstrate significant overlap with the narrative integrative meaning measures of growth in relation to health. The cognitive approach views narrative as a tool for evaluation and organization, and the findings from this study demonstrate significant overlap with the narrative structure of coherence in relation to health. Future studies will benefit from focusing on the overlapping aspects of narrative in addition to the unique aspects that explain health.

Caution must be paid to the present study's measure of verbal ability, as there are multiple means with which to assess this cognitive skill. For example, future studies can benefit

from executing more controlled verbal ability tasks in the lab—such as synonym and antonym vocabulary tests—because these measures assess how executive control and verbal fluency explain narrative expression. Additionally, verbal ability is related to other important cognitive factors involved in the narrative process that are not assessed in the study. For example, Klein and Boals (2010) observed that repeated personal narrations of stressful events increased working memory capacity. In other words, narrative expression appears to improve individual's ability to focus on problem solving by further inhibiting the intrusiveness and avoidant thoughts in working memory surrounding stressful experiences (Horowitz, 1975; 1993). Thus, working memory is likely important to the narrative process and relates to verbal ability (Unsworth, 2010), which makes it a meaningful cognitive factor that should be examined in greater depth.

Lastly, because this is a single time point study, the direction of effects cannot be revealed. Thus, this study represents a first step towards a more complete understanding of how multiple personality and cognitive factors influence the narrative meaning-making process in relation to concurrent health indices. Current work in the researcher's lab is now expanding these findings longitudinally. This study replicates and extends findings that narrative expression is a unique predictor for health at one point in time. If narrative is continually predictive at one point in time to the next, it should also be predictive of prospective changes in health. Importantly, individuals with more advanced verbal skills are not automatically better storytellers with greater levels of health. In addition to personality and cognitive skillsets, *how* personal stories are retold remain crucial.

References

Adler, J. M., Lodi-Smith, J., Philippe, F. L., & Houle, I. (2016). The Incremental Validity of Narrative Identity in Predicting Well-Being A Review of the Field and Recommendations for the Future. *Personality and Social Psychology Review*, *20*, 142-175.

Adler, J. M., Turner, A. F., Brookshier, K. M., Monahan, C., Walder-Biesanz, I., Harmeling, L. H., . . . Oltmanns, T. F. (2015). Variation in narrative identity is associated with trajectories of mental health over several years. *Journal of Personality and Social Psychology*, *108*, 476-496.

Baddeley, J. L., & Singer, J. A. (2008). Telling losses: Personality correlates and functions of bereavement narratives. *Journal of Research in Personality*, *42*, 421-438.

Baerger, D. R., & Berger, F. R., Gupta, W. B., & Berger, R. M. (1990). *Air Force officer qualifying test (AFOQT) Form P: Test manual*. PSYCHOMETRICS INC SHERMAN OAKS CA.

Berger, F. R., Gupta, W. B., Berger, R. M., & Skinner, J. (1990). Air Force Officer Qualifying Test (AFOQT) form P: Test Manual (AFHRL-TR-89-56). Brooks Air ForceBase, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives on psychological science*, *6*, 3-5.

Bruner, J. (1987). Life as narrative. *Social research*, 11-32.

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*.

Costa, P. T. Jr., & McCrae, R. R. (1992). *Revised NEO Personality Inventory* (NEO-PI-R) *and NEO Five-Factor Inventory* (NEO-FFI) *professional manual*. Odessa, FL:

Psychological Assessment Resources.

Cox, K., & McAdams, D. P. (2014). Meaning making during high and low point life story episodes predicts emotion regulation two years later: How the past informs the future. *Journal of Research in Personality, 50,* 66-70.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of personality assessment, 49*, 71-75.

Dunlop, W. L., & Tracy, J. L. (2013). Sobering stories: Narratives of self-redemption predict behavioral change and improved health among recovering alcoholics. *Journal of Personality and Social Psychology, 104*, 576-590.

Fivush, R. (2011). The development of autobiographical memory. *Annu Rev Psychol, 62*, 559-582.

Farrant, K., & Reese, E. (2000). Maternal style and children's participation in reminiscing: Stepping stones in children's autobiographical memory development. *Journal of Cognition and Development, 1*, 193-225.

Frattaroli, J. (2006). Experimental disclosure and its moderators: a meta-analysis. *Psychol Bull, 132*, 823-865.

Friedman, H. S., & Kern, M. L. (2014). Personality, well-being, and health. *Annual review of psychology, 65*, 719-42.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why?. *Current Directions in Psychological Science, 13*, 1-4.

Graci, M. E., Watts, A. L., & Fivush, R. (2018). Examining the factor structure of narrative meaning-making for stressful events and relations with psychological distress. *Memory,* 1-13.

Graham, J. E., Christian, L. M., & Kiecolt-Glaser, J. K. (2006). Stress, age, and immune function: toward a lifespan approach. *Journal of behavioral medicine*, *29*, 389-400.

Grysman, A. (2015). Collecting narrative data on Amazon's Mechanical Turk. *Applied Cognitive Psychology*, *29*, 573-583.

Horowitz, M. J. (1975). Intrusive and repetitive thoughts after experimental stress: A summary. *Archives of general psychiatry*, *32*, 1457-1463.

Horowitz, M. J. (1993). Stress-response syndromes. In *International handbook of traumatic stress syndromes* (pp. 49-60). Springer US.

Kafka, G. J., & Kozma, A. (2002). The construct validity of Ryff's scales of psychological well-being (SPWB) and their relationship to measures of subjective well-being. *Social Indicators Research*, *57*, 171-190.

Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: a latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General*, *133*(2), 189-217.

Klein, K., & Boals, A. (2001). Expressive writing can increase working memory capacity. *Journal of Experimental Psychology: General*, *130*, 520-533.

King, L. A., Scollon, C. K., Ramsey, C., & Williams, T. (2000). Stories of life transition: Subjective well-being and ego development in parents of children with Down syndrome. *Journal of Research in Personality*, *34*, 509-536.

Laible, D. (2004). Mother-child discourse in two contexts: links with child temperament, attachment security, and socioemotional competence. *Developmental psychology*, *40*, 979-992.

Laible, D., Carlo, G., Torquati, J., & Ontai, L. (2004). Children's perceptions of family relationships as assessed in a doll story completion task: Links to parenting, social competence, and externalizing behavior. *Social Development, 13*, 551-569.

Lilgendahl, J. P., Helson, R., & John, O. P. (2013). Does ego development increase during midlife? The effects of openness and accommodative processing of difficult events. *Journal of Personality, 81*, 403-416.

Lilgendahl, J. P., & McAdams, D. P. (2011). Constructing stories of self-growth: How individual differences in patterns of autobiographical reasoning relate to well-being in midlife. *Journal of Personality, 79*, 391-428.

Litman, L., Robinson, J., & Abberbock, T. (2016). TurkPrime. com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods,*1-10.

Lyubomirsky, S., Sousa, L., & Dickerhoof, R. (2006). The costs and benefits of writing, talking, and thinking about life's triumphs and defeats. *Journal of Personality and Social Psychology, 90*(4), 692-708.

McAdams, D. P. (1996). Personality, modernity, and the storied self: A contemporary framework for studying persons. *Psychological inquiry, 7*, 295-321.

McAdams, D. P., Reynolds, J., Lewis, M., Patten, A. H., & Bowman, P. J. (2001). When bad things turn good and good things turn bad: Sequences of redemption and contamination in life narrative and their relation to psychosocial adaptation in midlife adults and in students. *Personality and Social Psychology Bulletin, 27*, 474-485.

McLean, K. C., Pasupathi, M., & Pals, J. L. (2007). Selves creating stories creating selves: a process model of self-development. *Pers Soc Psychol Rev, 11*, 262-278.

McLean, K. C., & Pratt, M. W. (2006). Life's little (and big) lessons: identity statuses and meaning-making in the turning point narratives of emerging adults. *Developmental psychology*, *42*, 714-722.

Newcombe, R., & Reese, E. (2004). Evaluations and orientations in mother–child narratives as a function of attachment security: A longitudinal investigation. *International Journal of Behavioral Development*, *28*, 230-245.

Oppenheimer, D. M., Meyvis, T., & Davidenko, N. (2009). Instructional manipulation checks: Detecting satisficing to increase statistical power. *Journal of Experimental Social Psychology*, *45*, 867-872.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science*, *8*, 162-166.

Pennebaker, J. W., & Chung, C. (2011). Expressive writing and its links to mental and physical health. *Oxford handbook of health psychology*, 417-437.

Reese, E., Haden, C. A., Baker-Ward, L., Bauer, P., Fivush, R., & Ornstein, P. A. (2011). Coherence of personal narratives across the lifespan: A multidimensional model and coding method. *Journal of Cognition and Development*, *12*, 424-462.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual review of psychology*, *52*, 141-166.

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of personality and social psychology*, *57*, 1069-1081.

Rubin, D. C., & Wenzel, A. E. (1996). One hundred years of forgetting: A quantitative description of retention. *Psychological review*, *103*, 734-760.

Smyth, J., True, N., & Souto, J. (2001). Effects of writing about traumatic experiences: The necessity for narrative structuring. *Journal of Social and Clinical Psychology, 20,* 161-172.

Tessler, M., & Nelson, K. (1994). Making memories: The influence of joint encoding on later recall by young children. *Consciousness and cognition, 3,* 307-326.

Unsworth, N. (2010). Interference control, working memory capacity, and cognitive abilities: A latent variable analysis. *Intelligence, 38,* 255-267.

Walker, W. R., Skowronski, J. J., & Thompson, C. P. (2003). Life is pleasant--and memory helps to keep it that way!. *Review of General Psychology, 7,* 203-210.

Ware, J. E., Keller, S. D., & Kosinski, M. (1995). *SF-12: How to score the SF-12 physical and mental health summary scales*. Health Institute, New England Medical Center.

Waters, T. E., Bohanek, J. G., Marin, K., & Fivush, R. (2013). Null's the word: A comparison of memory quality for intensely negative and positive events. *Memory, 21,* 633-645.

Waters, T. E., & Fivush, R. (2015). Relations between narrative coherence, identity, and psychological well-being in emerging adulthood. *Journal of personality, 83,* 441-451.

Table 1

Demographic Descriptions for the 300 participants

Demographics	
Age	
mean	24.39
SD	2.67
range	18–29
Gender	
Male	40%
Female	60%
Income	
$0-9,275	30%
$9,276-37,650	42%
$37,651-91,150	27%
$90,150	.001%
Education	
Some high school	1%
High school	9%
Associates/technical college degree	15%
Some college education	32%
College degree	36%
Post graduate degree	7%
Ethnicity	
Caucasian	67%
Black/African American	11%
Hispanic/Latin-American	9%
Asian/Asian-American	6%
Multi-racial	5%
Native American/American Indian	1%
Another ethnicity	1%

Table 2

Narrative Coding Schemes

Structural Themes	Description	Reliability Statistic
Context	The narrator places the story in both time and place. Specificity of time includes dates or autobiographical moments (e.g., my first time flying on a plane). Specificity of location includes descriptions of physical locations. Low scorers have neither time nor place in their story.	ICC = .946
Chronology	Naïve listener can order almost all (> 75%) of the temporally relevant actions. Low scorers tell their stories in a disorderly and hard to discern manner.	ICC = .915
Theme	Narrative includes all the above and a resolution to the story, or links to other autobiographical experiences including future occurrences, or self-concept or identity. Low scorers do not elaborate beyond the facts of the experience.	ICC = .934
Meaning-Meaning Themes		
Growth	Higher scored narratives include how the event helped the person develop a better sense of self. Lower scored narratives include how the event inhibited a better sense of self.	ICC = .903

Table 3

Means, standard deviations and ranges for all 300 participants on all study variables

	Mean	SD	Range
Negative Event Coherence	6.72	1.90	1.00-9.00
Positive Event Coherence	6.71	2.03	0.00-9.00
Negative Event Growth	2.14	1.06	1.00-5.00
Positive Event Growth	4.23	0.73	1.00-5.00
Well-being	76.36	11.66	41.00-104.00
Life Satisfaction	22.20	7.02	5.00-35.00
Stress	17.43	7.98	0.00-35.00
Physical health	16.70	2.56	6.00-20.00
Neuroticism	26.73	8.93	5.00-48.00
Extraversion	26.66	6.69	8.00-44.00
Openness	32.85	6.37	17.00-47.00
Agreeableness	32.36	5.40	15.00-45.00
Conscientiousness	33.41	6.997	14.00-48.00
Verbal ability	9.33	16.70	1.00-17.00

Table 4

Correlations between all Independent Variables

	Negative Event Growth	Positive Event Growth	Negative Event Coherence	Positive Event Coherence
Negative Event Growth	-	-	-	-
Positive Event Growth	.04	-	-	-
Negative Event Coherence	.02	.21**	-	-
Positive Event Coherence	-.03	.24**	.52**	-
Verbal ability	.346**	-.093	.374**	.145*
Neuroticism	-.20**	-.06	.02	.03
Extraversion	.15**	.04	-.02	-.09
Openness	-.05	.10	.23**	.12*
Agreeableness	.04	.03	.14*	.12*
Conscientiousness	.15**	.09	.14*	.13*

Note: Statistical significance is denoted as follows: *p < .05; **p < .01; ***p <.001.

Table 5

Correlations between all Health indices and Independent Variables

	Well-being	Satisfaction with Life	Stress	Physical health
Well-being	-	.605**	-.567**	.465**
Life Satisfaction	-	-	-.605**	.361**
Stress	-	-	-	-.447**
Physical health	-	-	-	-
Negative Event Growth	.140*	.135*	-.133*	.157**
Positive Event Growth	.168**	.081	-.156**	.041
Negative Event Coherence	.232**	.069	-.025	.073
Positive Event Coherence	.210**	-.006	-.010	.042
Verbal ability	.236**	.008	-.094	.088
Neuroticism	-.612*	-.544**	.730**	-.446**
Extraversion	.463**	.397**	-.371**	.271**
Openness	.290**	-.024	-.012	-.002
Agreeableness	.503**	.235**	-.305**	.247**
Conscientiousness	.682**	.408**	-.451**	.395**

Note: Statistical significance is denoted as follows: *p < .05; **p < .01; ***p < .001.

Table 6

Zero-order Correlations between Well-being and Covariates

	Age	Gender	Income	Education	Negative Event Time Since	Negative Event Engagement	Positive Event Time Since	Positive Event Engagement
Well-being	.040	.153**	.230***	.115*	.120*	.125*	-.042	.167**
Life Satisfaction	.035	-.011	.201***	.132*	.116*	.013	-.094	.037
Stress	.052	.064	-.162**	-.099	-.102	-.022	.109	-.080
Physical health	.003	.012	.208***	.110	.042	.095	-.081	.118*

Note: Statistical significance is denoted as follows: *p < .05; **p < .01; ***p < .001.

Table 7

Hierarchical Multiple Regression between well-being on Personality Factors, Demographics, and Narratives

	Health Indices			
	Well-being (1)	Life Satisfaction (2)	Stress (3)	Physical Health (4)
Gender	.093*	.015	.031	.017
Income	.067	.054	-.020	.067
Education	-.002	.078	-.015	.023
Neuroticism	-.395***	-.375***	.686***	-.317***
Extraversion	.101*	.122*	.059	.040
Openness	.200**	-.044	-.020	-.003
Agreeableness	.111**	-.008	-.070*	.055
Conscientiousness	.323***	.171**	-.107*	.173*
Block 1 R2	.655***	.332***	.564***	.264***
Negative Event Growth	-.010	.017	.008	.061
Positive Event Growth	.020	.013	-.095*	-.071
Negative Event Coherence	.050	.099	-.001	.032
Positive Event Coherence	.130**	-.067	.015	.060
Block 2 ΔR2	.026***	.008	.008	.011

Note: Statistical significance is denoted as follows: *p < .05; **p < .01; ***p <.001. Only block 2 standardized beta's are reported.

Table 8

Hierarchical Multiple Regression between well-being on Cognitive Factors, Demographics, and Narratives

	Health Indices			
	Well-being (7)	Life Satisfaction (8)	Stress (9)	Physical Health (10)
Gender	.137*	-.011	.069	.015
Income	.213***	.170**	-.135*	.178**
Education	.021	.113	-.060	.050
Time since Negative Event	.100	.112	-.094	.041
Time since Positive Event	-.064	-.130*	.130*	-.067
Time of Engagement – Negative Event	-.021	-.041	.029	.035
Time of Engagement – Positive Event	.051	.028	-.068	.066
Verbal Ability	.168**	-.005	-.087	.084
Block 1 R2	.149***	.082**	.065*	.069**
Negative Event Growth	.133*	.106	-.116*	.138*
Positive Event Growth	.109	.093	-.162**	.032
Negative Event Coherence	.082	.082	.045	.001
Positive Event Coherence	.066	-.078	.061	-.019
Block 2 ΔR2	.049**	.027*	.041*	.020

Note: Statistical significance is denoted as follows: *p < .05; **p < .01; ***p <.001. Only block 2 standardized beta's are reported.

Appendix
Narrative Scoring Examples

Narrative Scoring	Example
Growth	
Low Score	The most negative experience of my life so far has been my grandmother dying unexpectedly. The phone call we got that she was in the hospital was out of the blue and I wasn't prepared. Since then I haven't been quite the same. I'm worried a lot more now that she got taken away. I worry about my own mother dying more often now. I'm scared of being alone, and it has greatly impacted me negatively since it happened a few years ago.
High Score	The most negative experience in my life would be my first marriage. She ended being a totally different person than what I had dated, prior to the marriage. I felt trapped at first, but then realized that life was just too short for this and that I had to make a change for my own happiness. Basically, she ended up cheating on me. The reason this was so negative for me was because I thought I knew her. I thought she wanted to be with me. Why else would you get married to someone? To have the one person that you trusted and loved stab you in the back is about as negative as it gets. I learned a lot from this experience though and look back on in kind of laughing. I was so young and so stupid to fall for a person like her. I still didn't deserve what she did, but I was still naive.
Coherence	
Low Score	One of the most negative experiences of my life was when my parents announced they were getting divorced. It put a pit in my stomach. I couldn't breath and it felt like I was in shell shock. It was so out of the blue that I had no idea how to process it. It felt like someone had died. I felt like crying and running away. I was just in so much shock that I just sat there, with no idea what to do or say.
High Score	After my first semester of graduate school, I flew back to join my girlfriend for winter break. It was a big relief to see her and my dog again. For the next month, I felt like I had the summer before I left: free, relaxed, and happy with my best friend. We got to do all of the normal things again (e.g., make breakfast, try new foods, run together) and finally get a break from the stress of long distance relationships. I was happy to do anything to help her out as she had been very busy with an internship and trying to care for our dog at the same time. The whole situation was a big relief because, back at school, I felt like l could never fully relax (i.e., bike getting stolen) and always feared that something might have happened to my car each time I walked to it. Additionally, I got to see my family again and, of course, they were happy to see me too.

The Longitudinally Stable Effects of Retelling Personal Narratives with Health

Matthew E. Graci

Emory University

Abstract

Whereas many studies investigate concurrent relations between personal narrative expressions and health, this study collected personal narratives and health indices across five points in time to investigate enduring relations across time. The present research collected data from 300 participants from an online community sample (m_{age} = 24.39, Age_{range} = 18-29; 60% self-identified as women; 100% US residents; 62% retention), who wrote about a highly positive and negative experience, as well as completed a series of individual difference measures at each time-point. All narratives were coded for coherence and growth. When controlling for personality traits, verbal ability and other cognitive factors, as well as demographics, coherence from positive event narratives related with higher life satisfaction across time, whereas growth from negative event narratives related to lower perceived stress across time. As narrative expressions dynamically unfold over time, the ways in which people narrate the stories of their lives across time is consistently and uniquely indicative of their health.

The Longitudinally Stable Effects of Retelling Personal Narratives with Health

The manner in which people narrate their past experiences is indicative of their present psychological states. A plethora of studies demonstrate that how people structure their personal experiences in a coherent manner (e.g., give it a theme, context, and sense of chronology) and layer it with an element of integrative meaning (e.g., expressing growth from an experience) concurrently relates to a number of health benefits (e.g., higher life satisfaction, lower depression; Adler, Lodi-Smith, Phillippe, & Houle, 2016). One's personal narratives matter over and above personality, and a number of cognitive factors, to explain psychological health—here defined as psychological well-being, satisfaction with life, perceived stress, and physical health. Yet there are still looming questions over the relationship between narrative and health across time. Both narrative expression and health dynamically change, yet they are rarely studied together beyond one point in time. Whereas we know that incremental validity exists in the relationship between narrative and health at a single time point, we do not know if these relationships have a lasting and robust effect— here defined as an effect that holds up across time and when considering multiple covariates. Thus, the central question of this study is whether narrative uniquely and consistently explains health; that is, is narrative a robust indicator of well-being over time?

Narrative Identity

The narrative identity literature focuses on how an individual's personal stories are critical components to one's self-understanding and personality (McAdams & McLean, 2013). A recent review of 30 narrative studies helps show that the manner in which people narrate their personal stories are uniquely predictive of health, even when considering participants' personality traits and demographics (Adler, et al. 2016). However, many of these studies come

from a personality perspective that focus on controlling for personality variables, while other important cognitive factors, especially verbal ability, remain under-examined when exploring the unique relationship between narrative and health. Two crucial components to one's narrative expression, *structure* (e.g., coherence) and *integrative meaning-making* (e.g., growth), relate with health, but we do not know if these factors remain unique when also considering cognitive factors, as well as across time, since many studies that demonstrate these effects are one time-point studies. Thus, it is not yet clear how consistent these unique associations between narrative expressions of structure and integrative meaning to multiple indices of health are over time—in other words, that narrative is a *robust* predictor of health beyond other important factors.

The first critical aspect of narrative expression that has been examined is coherence. Narrative coherence can be defined as the ordering of actions in a temporally appropriate manner, situated in place and time, and linked together to provide a meaningful theme for the experience (Reese, Haden, Baker-Ward, Bauer, Fivush, & Orstein, 2011). Coherent personal narratives are related to lower levels of depression, higher life satisfaction (Baeger & McAdams, 1999), and greater sense of psychological well-being (Waters & Fivush, 2015). The ability to coherently narrate personal experience reflects ongoing efforts to establish order and structure in one's life, which is a critical process in forming meaning and purpose in life (King, Heintzelman, Ward, 2016; McAdams & McLean, 2013), as well as a greater sense of health. If narrative coherence is an integral part of healthy meaning-making, then the relationship between narrative coherence and health should be robust when the window size of observation is expanded to simultaneously examine both constructs at multiple time points.

Another critical aspect of narrative expression that has been examined is growth. Narrative growth is defined as the extent to which people integrate the meaning of the event for

the self (e.g., "I am a wiser person now") with the facts, thoughts, and feelings of the experience. In particular, narrative growth is related to emotion regulation strategies (i.e., absence of rumination, presence of positive reappraisal; Cox & McAdams, 2004), as well as well-being (Lilgendahl & McAdams, 2011). The ability to embed a positive appraisal of the self-experiencing of events appears to be a healthy process of meaning-making. Yet similar to narrative coherence, the relationship between narrative growth and health has chiefly been investigated at one point in time. If narrative growth is also an integral part of healthy meaning-making, then the relationship between narrative growth and health should be found when the window size of observation is expanded to simultaneously examine both at multiple time points.

In summary, narrative coherence and growth appear to be unique predictors of health indices at one point in time. Many studies demonstrate that both narrative coherence and growth uniquely relate to health indices when controlling for other important factors, such as personality traits and demographics (see Adler et al, 2016, for full review), but this research raises two critical questions. First, narrative expressions differentially relate to health indices. Given that health is a multifaceted construct (e.g. hedonic vs eudemonic well-being; Ryan & Deci, 2001; Ryff & Singer, 2008), narrative expressions should be assessed in relation to multiple indices of health to better delineate specific patterns of relations (Graci, Watts, & Fivush, 2018). Second, personal narratives are emergent accounts of experiences that are actively revised and reinterpreted (Fivush, Booker & Graci, 2017; McLean, Pasupathi, & Pals, 2007). Such active construction of events enables individuals to have their own unique self-understanding and interpretation of the world. People actively revise and reinterpret their experiences over time, which has a continual impact on how they understand events and their associated thoughts and feelings (Fivush & Graci, 2018). This raises the critically important question about the

uniqueness of narratives over time. While narratives are assumed to dynamically change, how might they still robustly relate to health? A preliminary answer can be found in the expressive writing literature.

Expressive Writing

Engaging in expressive writing changes both one's linguistic account of experience and its emotional impact on the self. The general paradigm has individuals write about stressful experiences over a period of multiple days, and their physical and psychological health are assessed both before and after intervention. Participants are typically randomly assigned to an experimental expressive writing group and a control non-expressive writing group. Frattaroli's (2006) meta-analysis of 146 studies demonstrates how engaging in repeated narrations dynamically unfolds over time, and how situational factors moderate relationships between repeated narrations and health benefits.

Although there is a general positive effect of engaging in expressive writing, there are many situational factors that appear to reduce the likelihood that repeated narrations are related to better health over time. For example, number of writing sessions, length of the writing sessions (Walker, Nail, & Croyle, 1999), and spacing of the writing session (Harris, Thoresen, Humphreys, & Faul, 2005) help show people who take the time to adequately process these events are the ones that typically benefit from the expressive writing process. Moreover, those who write about superficial (Pennebaker, 1997) or even positive events (Lyubomirsky, Sousa, & Dickerhoof, 2006) do not typically find any benefits from the process, further elucidating the contexts in which people benefit from the expressive writing process. Expressive writing about distressing events is the most frequent context where participants demonstrate greater levels of positive health following the intervention, suggesting that expressive writing is particularly

beneficial when about events that are challenging or difficult to process for the self. However, more work investigating the relationships between event valence and health is needed.

Further, most expressive writing studies do a basic linguistic word count analysis of participants' writing, which appears to change across days. In particular, aspects of structure tend to increase over time, as indexed by increases in words like "realize" and "understand." Also, aspects of affective appraisals tend to change over time, as indexed by increases in positive affect words like "happy" and decreases in negative emotion words like "depressed" and "angry" (Pennebaker & Chung, 2011). Thus, changes in health and word level in narrative accounts are typically observed in expressive writing, particularly when writing about negative experiences. However, the lack of finer-grained content analysis over time makes it difficult to determine the underlying reasons why repeated narrations of negative events appear to increase health.

There is also some suggestion in the narrative identity literature that narrative meaning-making occurs in more contexts than resolving hardships or disruptions of experiences (McAdams, 2008). For example, people higher in dispositional optimism more positively construct events (McLean & Pratt, 2006; Scheier & Carver, 1985), which is related to better adjustment (Scheier & Carver, 1985), and which highlights the similarities across negative and positive events (Lilgendahl & McAdams, 2011). Thus, deeper content analysis needs to be implemented on both positive and negative event narrations to further specify the relationships between narrative and health.

Narrative Relations with Health Over Time

Longitudinal narrative studies help elucidate if and how narrative meaning-making has a positive impact on health. Longitudinal analyses of repeated personal narrations can be broken down into three kinds of study designs. These designs address prospective and retrospective

changes in health. Very few studies look at both narrative and health over multiple points in time. As such, it is still difficult to determine if there are unique and consistent relationships between narrative and multiple indices of health over time—in other words, that narrative is a robust predictor of health.

The first type of longitudinal design investigates the *prospective* effect of narrative expression on health. This design entails measuring both psychological health and narratives at time one and then psychological health at time two or additional later times (Adler et al., 2015; Bauer & Bonanno, 2001; Bauer & McAdams, 2010; Dunlop & Tracy, 2013; King & Raspin, 2004; Mansfield, Pasupathi, & McLean, 2015; Pals, 2006). For example, individuals who narrated their difficult life experience at age 52 with more coherent positive resolution showed increased life satisfaction at age 62 (Pals, 2006), and individuals with higher levels of self-redemption about their alcohol recovery were more likely to remain sober and have higher levels of physical and mental health a year later than individuals who expressed less self-redemption (Dunlop & Tracy, 2016). The manner in which individuals narrate challenging experiences, compared to highly positive experiences, appear to be more indicative of prospective health (Adler et al., 2016). However, in order to understand narrative as a more robust predict of health, more than one collection of narratives is needed; if narrative is a robust emergent property of self-understanding and health, then simultaneous measures of narrative and health need to also be assessed across time.

The second longitudinal design investigates the *retrospective* effect of narrative expression on health. This design entails the measurement of psychological health at time point one and the collection of both psychological health and narratives at time-point two (Lodi-Smith et al., 2009; Mansfield et al., 2015; Tavernier & Willoughby, 2011). For example, individuals

who narrated their transgressions with higher levels of growth showed increased self-compassion after controlling for initial levels of self-compassion collected one month prior (Mansfield et al., 2015). Similar to Pals' study on difficult life experiences, Mansfield and colleagues conclude that narratives may be indirectly involved in emotional regulation and health, such as self-compassion. Other researchers have found that individuals who showed higher levels of affective processing in narratives at a later time point also showed significantly higher levels of increase in composite mental health (i.e., self-esteem, life satisfaction, adjustment, depression, stress) from time-point one to two, over and above personality change (Lodi-Smith et al., 2009). Overall, this design helps us understand how changes in health may have occurred because of narrative processing, given its contributions in explaining variance in health chances. However, it is again difficult to predict the extent to which the observed trends might continue into the future since no measurement of past patterns exists. If narrative is a robust emergent property of self-understanding and health, particularly for negative experiences, as in studies of this design, then simultaneous measures of narrative and health need to also be assessed at an *earlier* time.

The third design looks at the repeated prospective effect narrative expression has on health. This design includes collecting multiple simultaneous narratives and health indices over time, and thus is the strongest design to carry out. Only two studies to date have used this design, and they both used the same sample of only 47 participants narrating about their experience undergoing therapy. Still, these studies observe how narratives temporally precede changes in health. In particular, greater agency, but not coherence, in narratives relates to greater decreases in clinical symptomology in later sessions (Adler, 2012). Interestingly, in another study from the same sample, sudden decreases in clinical symptomology could be understood by sudden increases in coherence in previous sessions (Adler, Harmeling, & Walder-Biesanz, 2013), so the

relationship between coherence and health may be more indicative of health at specific points in one's life, and/or follow a nonlinear pattern. People can start to tell new versions of past stories—versions with greater agency or increases in structure—and these narrative changes relate to later improvements in health. However, additional research needs to be executed on larger and more diverse samples in order to understand how narratives uniquely relate to health in the current and later moments. In addition, it is important to examine narratives by different emotional valences. On the one hand, narrative appears to function as an emotion-regulation tool that aids in ameliorating suffering and hardships (Fivush, 2011). On the other hand, narrative also functions as an identity-informing tool that utilizes both negative and positive experiences to create an overarching life story (McAdams, 2008). Thus, both negative and positive valenced narratives need to be collected in order to better assess how each relates to health.

The present study

The present study investigates if narrative is a robust indicator of health when examining relations over time alongside other important factors. This study goes beyond previous research in four ways. First, this study directly measures verbal ability, along with personality traits, time since the event, and basic demographics, to specify the extent to which narrative uniquely relates to health across time. Second, given the many findings in different forms of health, aspects of positive and negative psychological health and physical health were assessed to attempt to disentangle the complex relationships between narrative and health (Graci, Watts, & Fivush, 2018). Third, given that narrative appears especially crucial to explain disruptive experiences, narratives from negative and positive events were compared. Fourth, this study investigates its hypotheses with a large, diverse sample of 300 people from around the United States.

The present study utilizes an increasingly popular and validated participant pool, Amazon's Mechanic Turk (Mturk). Mturk is an efficacious platform to use for research. Recent studies have found Mturk workers to be a more diverse participant pool and have the same data quality as more traditional participant pools, such as undergraduate students (Buhrmester, Kwang, & Gosling, 2011). In particular, the quality of narratives is comparable across undergraduate populations and Mturk participants (Grysman, 2015).

The present hypotheses are threefold:

1) *Higher narrative coherence is expected to robustly relate to measures of health over time, controlling for demographics, personality and cognitive factors. Relationships to specific health indicators are more exploratory.*
2) *Higher narrative growth is expected to robustly relate to measures of health over time, controlling for demographics, personality and cognitive factors. Relationships to specific health indicators are more exploratory.*
3) *Narrative expression from negative events is expected to be predictive of health, whereas narrative expression from positive events is not expected to carry much explanatory power over time.*

Method

Data were collected as part of a larger longitudinal data collection examining how people narrate highly emotional experiences over time. During the first time-point of data collection, participants were assessed on their personality and cognitive factors, in addition to writing narratives and being assessed on their levels of health. The following four time-points only prompted participants to write narratives and fill out the health questionnaires.

In total, 300 people participated in the first wave of data collection (m_{age} = 24.39, range from 18 to 29; 60% self-identified as women). Participants had a fairly even distribution of educational background; the majority of the participants reported a college degree (36%) or some college education (32%). Sectioned off by 2016 IRS tax brackets, participants also had a fairly even distribution of economic backgrounds, as the majority of the participants reported a salary of $9,276-37,650 (42%) or others who made $0-9,275 (30%). The participants self-identified as predominately Caucasian (67%). Please see Table 1 for a full breakdown of demographics.

Procedure

All procedures were approved by Emory Uuniversity's Institutional Review Board. Data were collected using Amazon's Mechanical Turk (Mturk) platform via TurkPrime, which automated parts of the data collection process (Litman, Robinson, & Abberbock, 2016). Participants received $1 for participation at all time-points of data collection. Participants also received increasing bonuses as the study progressed (Time-point 2: $1; Time-point 3: $1.5; Time-point 4: $2; Time-point 5: $4). The participants were provided 90 minutes to complete the entire survey. On average, participants took 39.48 minutes (±18.26 minutes) to complete the study. The study consisted of filling out a series of demographics, health measures, counter-balanced negative and positive narrative prompts, and then a series of individual difference surveys and tasks. Time-points 2 through 4 occurred approximately 1 week after the previous point. Time-point 5 was a 1 month follow-up from time-point 4. Time-points 2 through 5 were the same format, beginning with the four well-being measures and then the counter-balanced negative and positive narrative prompts. See Table 2 for a data collection flow chart.

Inclusion Criteria. There were several requirements for Mturk workers to participate in the study. Participants had to live in the United States (verified by an I.P. address checker), be a

native English speaker, and 18-30 years old. In addition, another suggested inclusionary criteria on Mturk is to only allow participants that have a 90 rating or above on Mturk (e.g., workers that do not complete tasks/studies garner lower ratings) and a history of participation in over 100 others tasks/studies overall, in order to help ensure stronger data quality (citation).

Exclusion Criteria. Participants were excluded from the study when their data quality was demonstrably poor. Two instructional attention checking questions (Oppenheimer, Meyvis, & Davidenko, 2009) were included in the data collection (e.g., "please select agree for this question"). Participants were excluded from the participant pool when they failed both attention checking questions and completed the study under 1.5 standard deviations below the average time of completion (i.e. in approx. 5 or less minutes), or verifiably copied and pasted their narratives from an internet source via google search (e.g., submitted video game reviews instead of personal narratives). In total, 19 of the total 319 workers surveyed were excluded from the analytic dataset based on these criteria, but were still compensated for their time. In addition, given that the study was on the repeated narration of personal experiences, if participants failed to respond to the email that following week's survey was then open, as well as the reminder email that following week's survey was still open for participation, for both time-point 2 and time-point 3, then they were not invited back for time-point 4 and time-point 5. In total, 42 participants from time-point 1 failed to act on the four emails about further participation in the study and, thus, were not invited back for time-point 4 and time-point 5.

Narrative prompt. The negative and positive narrative writing prompts were adopted from the expressive writing literature (Pennebaker, 1997):

> For the next 10 to 15 minutes, please write about the most negative [positive] experience of your life. This should be an extremely emotional event that has affected you and your life. Please include the facts of the event, as well as your deepest thoughts and feelings. All

> of your writing will be kept confidential. Do not worry about spelling, sentence structure, or grammar, but please keep writing for 10 to 15 minutes.

The order of completion of tasks was as follows: basic demographics, the four health surveys, the counter-balanced narrative prompts, personality traits, and then verbal ability. The counter balancing of narrative prompts was performed using *Qualtrics* counter-balancing functionality, in which the platform randomly presents the negative narrative prompt first 50% of the time across the sample.

The narrative prompts for time-points two through five were slightly different from time point one. In particular, after writing narratives for time-point one, participants were asked to provide a keyword to help them remember what they wrote about for the following time-point. Participants had their unique keyword inserted into their narrative prompt, which looked as followed:

> For the next 10 to 15 minutes, please write about the most negative [positive] experience of your life again. To remind you, you previously about talked: [unique keyword]. Please include the facts of the event, as well as your deepest thoughts and feelings. All of your writing will be kept confidential. Do not worry about spelling, sentence structure, or grammar, but please keep writing for 10 to 15 minutes.

The order of completion of tasks was as follows: the four health surveys, counter-balanced narrative prompts, along with keywords for the following sessions. Again, the counter balancing of narrative prompts was performed using *Qualtrics* counter-balancing functionality, in which the platform randomly presents the negative narrative prompt first 50% of the time across the sample.

Narrative Coding

Narratives were coded for coherence along three dimensions, as outlined by Reese and colleagues (2011): coherence: theme, context, and chronology, and for growth (Lilgendahl &

McAdams, 2011). As stated in the introduction, coherence taps the underlying structure of personal narratives, whereas growth taps the underlying integrative processing of personal narratives. Please see Table 3 for more details on the coding schemes, as well as the basic statistics for each dimension. See also Appendix A for examples of scoring the narratives.

Each narrative indicator was coded by two to three independent coders. Whereas the specific coders were different for some narrative indicators, the training and reliability procedure was the same. For each narrative indicator, all coders learned the specific coding scheme through reading and discussion of that coding manual. Then, the coders used a predetermined set of the narratives during the coding training phase. During this phase, the coders discussed each narrative code in depth. After training, a previously unexamined subset of narratives (approximately 60 narratives) was coded independently by each coder in order to compute reliability. Once reliability was established, the two coders scored the rest of the dataset, including recoding the narratives used during the training phase. To check for coding drift, two additional subsets of 20 narratives were independently coded by both coders approximately 50% and 75% through coding each scheme. Thus, a total of 100 narratives constitutes the reliability statistics shown to the rightmost column in Table 3.

Health Measures

The study relied on four indicators of health in order to tap theoretically different aspects of psychological health (Ryan & Deci, 2001). The measures tapped both psychological and physical health, as detailed below.

Life Satisfaction was assessed using the *Satisfaction with Life Scale* (Diener, Emmons, Larsen, & Griffin, 1985), which comprises 5-items rated on a 7-point scale (1= *Strongly disagree* and 7 = *Strongly agree*). For example, “The conditions of my life are excellent.” Negatively

worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent greater satisfaction with life. For all time-points, reliability on this scale was strong for this sample (α = .90 to .92).

Psychological well-being was assessed using the *Brief Personal Well-being Scale, short form* (Ryff, 1989), which comprises 18-items rated on a 6-point scale (1= *Strongly disagree* and 6 = *Strongly agree*). For example, "I have confidence in my opinions, even if they are contrary to the general consensus." Based on empirical recommendations to bolster reliability, the six subscales (i.e., Positive relations, Autonomy, Environmental mastery, Purpose in Life, Personal Growth) were summed together for one composite measure (Kafka & Kozma, 2002). Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent higher rated psychological well-being. For all time-points, reliability on this scale was strong for this sample (α =.86 to .90).

Stress was assessed using the *Perceived Stress Scale* (Cohen, Kamarck, & Mermelstein, 1994), which comprises 10-items rated on a 5-point scale (0 = *Never* and 4 = *Very Often*). For example, "In the last month, how often have you been upset because of something that happened unexpectedly?" Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent higher rated stress. For all time-points, reliability on this scale was strong for this sample (α = .89 to .93).

Physical health was assessed using the *SF-12 form* (Ware, Kosinski, & Keller, 1995), which comprises 12-items, varying in scale. For the purposes of this study, we did not score the six mental health items. Thus, only the four domains of physical health (i.e., physical function, role physical, bodily pain, general health) were scored. For example, "During the past week, how much did pain interfere with your normal work (including work outside the home and

housework)?" Negatively worded items were reverse coded, and then all items were summed together. Thus, higher scores represent higher rated physical health. For all time-points, reliability on this scale was acceptable for this sample (α = .76 to .86).

Individual Difference Measures

Personality traits were assessed using the *NEO Five Factor Inventory* (Costa & McCrae, 1992), a widely-used and well-validated general personality measure, which consists of 60 items discerning stable dispositions along five dimensions: Extraversion, Neuroticism, Agreeableness, Conscientiousness, and Openness to Experience. Each item was assessed on a 5-point scale (0 = *strongly disagree* and 4 = *strongly agree*) and within-dimension items were summed. Reliability for all traits was strong for this sample for this sample (α =.81; .88; .78; .88; .80, respectively)

Verbal ability was assessed using the Air Force Officer Qualifying Test, as it is an indicator of fluid intelligence (Unsworth, 2010). The verbal analogies task entails reading incomplete analogies and selecting one out of five possible words that best completed the analogies. The participants were provided one practice item, and then were provided 5 minutes to complete 18 test items. An example item is "EXCITEMENT is to BOREDOM as PASSION is to: A) Nostalgia; B) Ignorance; C) Fatigue; D) Interest; *E) Indifference*." These items were drawn from the air force officer qualifying test (AFOQT; Berger, Gupta, Berger, & Skinner, 1990), and pulled from the same subset as Kane, Hambrick, Tuholski, Wilhelm, Payne, and Engle (2004). The participants' total correct responses were summed together. Thus, higher scores represent higher verbal ability. Reliability for verbal ability was acceptable for this sample (α = .78).

Data Analytic Plan

Preliminary analyses entailed basic descriptives on all variables, and analyses on zero-order correlations between all measures. To address the primary study question—do narrative expressions over time predict health over time—a series of longitudinal mixed-models were performed using hierarchical linear modeling (HLM; model equations can be found in the Appendix B, testing covariate and narrative expression patterns effects on the overall intercept.) Unconditional growth models were first carried out on narrative expressions to better understand if they change over time. Model 1 concerns psychological well-being. Model 2 concerns life satisfaction. Model 3 concerns perceived stress. Model 4 concerns physical health.

Linear time was integer-based (0, 1, 2, 3, 7) and a random effect was included with linear time. Across models, demographics, personality factors, and cognitive factors were treated as invariant. Narrative expression and time spent on writing the narratives (i.e., a measure of engagement) were treated as time-varying. The R statistical program was used for analyses (R Core Team, 2016; RStudio Team, 2015) along with the lme4 (Bates, Maechler, Bolker, & Walker, 2015), lmerTest (Kuznetsova, Brockhoff, & Christensen, 2017), and sjPlot (Lüdecke & Schwemmer, 2017) packages. The present study utilized HLM to accurately measure variances and covariance across multiple predictors by incorporating within-subject deviance into its estimation algorithms (Raudenbush & Bryk, 2002; Singer & Willet, 2003).

Results

Attrition. All participants completed time point 1 of the study, which included all time-measurement of all invariant variables (i.e. demographics and cognitive and personality factors). There were 300 participants for time-point 1, 244 for time-point 2, 221 for time-point 3, 197 for time-point 4, 186 for time-point 5. Thus, 186 out of 300 (62%) completed the time point 5. Of the 114 participants that did not participate at time-point 5, 42 had not been to return because of

their lack of participation in time points 2 and 3. No mean-differences regarding demographics and narrative measures were found between the 42 people not invited back to participant in time points 4 and 5 and the people in the analytic dataset. Moreover, when participation (or lack thereof) was treated as a continuous variable for all 300 participants (e.g., participated all time-points = 5, participated in two time-points = 2), no trends were observed between basic demographic and narratives with times participating. For this sample, data were not imputed, as HLM incorporates all available lower-level data (i.e., time-varying data among individuals; Bryk & Raudenbush, 1992). Thus, 1065 to 1073 observations from 300 participants were available for models. All equations are in Appendix B.

Descriptives. See Table 4 for descriptives of all *n*'s, means, standard deviations, ranges for all time-varying variables and Table 5 for all time-invariant variables. Also see Figure 1 for boxplots on all health indices over time. The most narrated topics for negative memories concerned Accidents/illnesses (37.33%) whereas the majority of the narrated positive memories concerned Interpersonal relations (50.00%). Please see Table 6 for more details on all narrated categories. In total, only 65 out of 300 people switched topics when narrating negative experiences over time, and 55 out of 300 people switched topics when narrating positive experiences over time. Participants spent, on average, 7.67 minutes (± 5.81 minutes) writing negative experiences and 7.75 minutes (± 7.17 minutes) writing about positive experiences. Table 7 shows correlations between all measures at baseline.

Hierarchical Linear Models

Narrative expressions as outcomes. In order to understand if and how narrative coherence and growth dynamically changed over time, unconditional growth models were performed. In particular, time was used to predict narratives across time. Narrative growth from

positive events decreased from baseline to one-month follow-up (*b* = .04, *CI* = [.02, .07]). Narrative growth from negative events increased from baseline to one-month follow-up (*b* = -.02, *CI* = [-.04, -.01]). Narrative coherence from negative events decreased from baseline to one-month follow-up (*b* = -.13, *CI* = [-.17, -.08]), as well as from positive events (*b* = -.10, *CI* = [-.15, -.06]). All narrative expressions rather minimally, but significantly, changed over time.

Psychological Well-being. Table 8 depicts the fixed and random effects for patterns of psychological well-being levels. An unconditional growth model on psychological well-being was first run in order to determine how variance was at the individual level (*ICC* = .891). There were multiple time-invariant predictors that explain well-being at baseline, such that people with higher verbal ability, lower trait neuroticism, higher trait-openness, higher trait-agreeableness, higher trait-conscientiousness, and women reported greater well-being at baseline. No time-varying predictors such as narrative growth and coherence predicted health across time. See Table 8 for more details.

Satisfaction with Life. Table 9 depicts the fixed and random effects for patterns of psychological life satisfaction levels. An unconditional growth model on life satisfaction was first run in order to determine how variance was at the individual level (*ICC* = .894). There were multiple time-invariant predictors that explain life satisfaction at baseline, such that people with lower verbal ability, higher trait-agreeableness reported greater life satisfaction people who reported their negative events closer in time reported greater life satisfaction at baseline. Importantly, participants who demonstrated increases in the narrative coherence in their positive event narratives over time demonstrated increases in life satisfaction over time.

Perceived Stress. Table 10 depicts the fixed and random effects for patterns of psychological perceived stress levels. An unconditional growth model on perceived stress was

first run in order to determine how variance was at the individual level (*ICC* = .705). There were multiple time-invariant predictors that explain perceived stress at baseline, such that people with lower verbal ability, lower trait-conscientiousness, people who reported their positive events closer in time, and increased their time spent writing their positive narratives demonstrated increases in stress at baseline. Importantly, participants who demonstrated increases in narrative growth in their negative event narratives over time demonstrated decreases in perceived stress over time.

Physical Health. Table 11 depicts the fixed and random effects for patterns of physical health. An unconditional growth model on physical health was first run in order to determine how variance was at the individual level (*ICC* = .806). There were multiple time-invariant predictors that explain physical health at baseline, such that people with higher verbal ability, lower trait-neuroticism, and higher trait-conscientiousness demonstrated higher physical health at baseline. No time-varying predictors such as narrative growth and coherence predicted health across time. See Table 8 for more details.

In summary, participants who increased their level of coherence in their positive narratives over time related with increased life satisfaction, and participants who increased their level of growth in their negative narratives over time related with decreased stress over time.

Discussion

The ways in which people narrate the stories of their lives across time is consistently and uniquely indicative of their health. As narrative expressions dynamically unfold over time, coherence explains life satisfaction and growth explains stress levels. The robustness of these relationships held in two crucial ways: 1) while controlling for personality and cognitive factors; and 2) across five points in time. Even when controlling for individuals' time-invariant factors,

including verbal ability and personality traits, the findings support the hypotheses that higher narrative coherence and growth predict better health over time; but, interestingly, these patterns vary by the emotional valence of the event.

Narrative coherence of positive events consistently explained higher life satisfaction across five time-points. Whereas the narrative identity literature might not predict that coherence of positive events is indicative of health, the attachment literature would predict this finding. Attachment researchers contend that secure attachment style fosters emotional equanimity, leading to better adjustment and organized representation of experiences that, in turn, lead to more of the same across time (Mikulincer & Shaver, 2007). In other words, secure attachment primes later secure attachment, like positive experiences beget more positive experiences because they act as continued buffers against negative appraisals of the self and the world around them—this is the broaden and build hypothesis (Fredrickson, 2004). The present study offers yet more evidence for the broaden and build hypothesis at the narrative level (Graci & Fivush, 2017) by observing that higher coherence from positive events is robustly predictive of life satisfaction over time.

Narrative coherence from negative events was not a significant predictor of any indices of health. Several studies indicate coherence from negative events is concurrently indicative of health (Baeger & McAdams, 1998; Waters, Shallcross, Fivush, 2013), but one longitudinal study also showed that narrative coherence did not predict clinical symptomology over time (Adler, 2012). Yet in that same sample, sudden improvements in symptomology at single time-points could be explained by sudden increases in coherence at earlier single time-points (Adler et al., 2015). These discrepant findings suggest that coherence may be a more nuanced construct, and that changes in coherence over time might be more important than current level of coherence.

Perhaps that structure of narratives from difficult experiences is indicative of positive health only after a level of closure, or processing, of the event has been achieved (Boals, Banks, Hathaway, & Schuettler, 2011; Klein & Boals, 2010). If this interpretation is correct, then coherence from distressing events might be more indicative of longer term prospective health, after enough time has passed to fully process and close the event, rather than concurrent health. Indeed, we are currently investigating this possibility, and finding that coherence predicts symptoms of distress over a 12-month period (Booker et al., in prep).

In contrast to coherence, narrative growth from negative events consistently explained lower stress across five points in time. Growth from negative, but not positive events, likely indicates emotion regulation levels, rather than direct levels of well-being. In particular, previous one time-point studies have observed that growth relates to greater maturity (Bauer & McAdams, 2010) and lower stress (Cox & McAdams, 2004). Moreover, one longitudinal study has observed that growth relates to outcomes like self-compassion, rather than psychological well-being (Mansfield et al., 2015). Mansfield and colleagues suggested that individuals can have a growth-oriented narrative style, in which they are frequently incorporating both positive and negative aspects of events in order to foster an adaptive view of the self despite the disruptive nature of negative events. Thus, the findings from the present study lends further support to the idea that repeated narrations of growth from negative events are associated with emotion regulation.

Importantly, narratives were a robust predictor of health even when accounting for time-invariant factors, although many of these factors were also directly related to health. More specifically, the present study is one of the few to directly examine the notion that narrators with higher verbal ability might be the healthier storytellers. Individuals' intelligence quotient (IQ), which is highly correlated with verbal ability, relates to an array of positive outcomes, in part

because people with higher IQs also possess elevated reasoning, problem-solving, and learning abilities (Gottfredson & Deary, 2014). The present study's measure of verbal ability, an indicator of fluid intelligence (Unsworth, 2010), explained all four indices of health at baseline—psychological well-being, life satisfaction, perceived stress, and physical health—when accounting for their traits and narrative expressions across time. In addition, the present study also examined personality traits as time-invariant predictors of health. Increased trait neuroticism (i.e., emotional instability) and decreased trait conscientiousness (i.e., impulsiveness), in particular, were the most frequent significant predictors of poorer health at baseline, in line with previous findings that observed that traits relations to both narrative and health (McAdams et al., 2006). Thus, both verbal ability and personality traits remain important factors to consider in examining the unique relationship between narrative and health; but, critically, narrative expression over time still accounted for unique variability in health over time.

It is important to emphasize that narrative was a robust predictor of health, even though narrative was changing over time. In particular, growth from negative events increased over time, further demonstrating that narrators take the opportunity to reflect on the disruptive nature of events and its impact on the self in a more organized manner (Pennebaker & Chung, 2011), while growth from positive events decreased over time, further demonstrating that narrators taking the opportunity to reflect on positive events can unintendedly lead to reconsidering the magnitude of positivity, including the potential happenstance, or lucky, nature of positive event (Lyubomirsky, Sousa, & Dickerhoof, 2006). Moreover, coherence of both positive and negative event narratives decreased over time. These findings run counter to the idea that coherence is generally stable for individuals across time (Waters, Kober, Raby, & Habermas, 2018). Yet coherence is a difficult construct to define (Adler, Waters, Poh, & Seitz, 2018; McAdams, 2006);

coherence can be conceptualized at either an event level, or local coherence, as well as at the life story level, or global coherence (McAdams, 2006), and both may change as a function of audience and the telling context (Pasupathi & Hoyt, 2010). The decreases in the present study's measure of coherence might be decreasing because the perceived audience—the researchers—are now assumed to be more knowledgeable about participants' overarching life stories. Regardless, coherence remains a significant predictor of stress and life satisfaction.

Finally, some limitations of this study must be noted. First, we used only one measure of verbal ability. Future studies can benefit from executing more controlled verbal ability tasks in the lab—such as synonym and antonym vocabulary tests—because these measures assess how executive control and verbal fluency explain narrative expression. Additionally, verbal ability is related to other important cognitive factors involved in the narrative process that were not assessed in the study. For example, Klein and Boals (2001) observed that repeated personal narrations of stressful events increased working memory capacity. In other words, narrative expression appears to improve individual's ability to focus on problem-solving by further inhibiting the intrusiveness and avoidant thoughts in working memory surrounding stressful experiences (Horowitz, 1975; 1993). Thus, working memory is likely important to the narrative process and relates to verbal ability (Unsworth, 2010), which makes it a meaningful cognitive factor that should also be studied across time, along with narratives.

Caution must also be paid to the demand characteristics of participants repeatedly completing the same health indices over time, in that participants might have hoped they would improve over time just by virtue of repeatedly filling the surveys. Finally, no causal arguments can be inferred from this study about narrative expressions and changes in health. Future studies should investigate the consistent prospective effect of narrative on health, like Adler (2012).

Future studies should especially examine the timing of relations between narrative and health. For example, individuals grappling with negative experiences might display higher distress, as well as stress-related growth (Waters et al., 2011; King et al., 2000), from the event until it has been resolved (Boals et al., 2011; Klein & Boal, 2010). In other words, not all narrative expression should be expected to be consistently concurrently indicative of the same indices of health over time.

The present study investigated if narrative is a robust indicator of health when examining relationships over time, and when accounting for other important factors. The study measured a wide range of person level variables, including personality and cognitive factors, as well as basic demographics, from 300 people across the United States. The present study aimed to disentangle the complex relationships between narrative and health by measuring multiple narratives and multiple measures of health. Narrative coherence and growth are robust predictors of life satisfaction and lower stress, respectively. The manner in which people narrate their past experiences is an enduring window into their psychological states.

References

Adler, J. M. (2012). Living into the story: Agency and coherence in a longitudinal study of narrative identity development and mental health over the course of psychotherapy. *Journal of personality and social psychology*, *102*, 367-389.

Adler, J. M., Harmeling, L. H., & Walder-Biesanz, I. (2013). Narrative meaning making is associated with sudden gains in psychotherapy clients' mental health under routine clinical conditions. *Journal of consulting and clinical psychology*, *81*, 839-845

Adler, J. M., & Hershfield, H. E. (2012). Mixed emotional experience is associated with and precedes improvements in psychological well-being. PLoS One, 7, e35633.

Adler, J. M., Lodi-Smith, J., Philippe, F. L., & Houle, I. (2016). The Incremental Validity of Narrative Identity in Predicting Well-Being A Review of the Field and Recommendations for the Future. *Personality and Social Psychology Review*, *20*, 142-175.

Adler, J. M., Skalina, L. M., & McAdams, D. P. (2008). The narrative reconstruction of psychotherapy and psychological health. Psychotherapy Research, 18, 719-734.

Adler, J. M., Turner, A. F., Brookshier, K. M., Monahan, C., Walder-Biesanz, I., Harmeling, L. H., . . . Oltmanns, T. F. (2015). Variation in narrative identity is associated with trajectories of mental health over several years. Journal of Personality and Social Psychology, 108, 476-496.

Adler, J. M., Waters, T. E., Poh, J., & Seitz, S. (2018). The Nature of Narrative Coherence: An Empirical Approach. *Journal of Research in Personality*, *74*, 30-34.

Baerger, D. R., & Berger, F. R., Gupta, W. B., & Berger, R. M. (1990). *Air Force officer qualifying test (AFOQT) Form P: Test manual*. PSYCHOMETRICS INC SHERMAN OAKS CA.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). lme4: Linear mixed-effects models using Eigen and S4. R package version 1.1–7. 2014.

Bauer, J. J., & Bonanno, G. A. (2001). I Can, I Do, I Am: The Narrative Differentiation of Self-Efficacy and Other Self-Evaluations while Adapting to Bereavement. Journal of Research in Personality, 35, 424-448.

Bauer, J. J., & McAdams, D. P. (2010). Eudaimonic growth: Narrative growth goals predict increases in ego development and subjective well-being 3 years later. *Developmental Psychology, 46*, 761-772.

Berger, F. R., Gupta, W. B., Berger, R. M., & Skinner, J. (1990). Air Force Officer Qualifying Test (AFOQT) form P: Test Manual (AFHRL-TR-89-56). Brooks Air ForceBase, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Boals, A., Banks, J. B., Hathaway, L. M., & Schuettler, D. (2011). Coping with stressful events: Use of cognitive words in stressful narratives and the meaning-making process. *Journal of Social and Clinical Psychology, 30*, 378-403.

Booker, J., Graci, M.E., Heitz, H., Hudak, L. Jovanovic, T., Rothbaum, B. … Stevens, J. (In prep). Coherence in Adults' Same-Day and Twelve-Month Recollections of Traumatic Experiences: Predicting Twelve-Month Depressive and Posttraumatic Symptoms.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives on psychological science*, *6*, 3-5.

Bryk, A. S., & Raudenbush, S. W. (1992). Hierarchical Linear Models Newbury Park. *Calif: Sage Publications*.

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*.

Costa, P. T. Jr., & McCrae, R. R. (1992). *Revised NEO Personality Inventory* (NEO-PI-R) *and NEO Five-Factor Inventory* (NEO-FFI) *professional manual*. Odessa, FL: Psychological Assessment Resources.

Cox, K., & McAdams, D. P. (2014). Meaning making during high and low point life story episodes predicts emotion regulation two years later: How the past informs the future. *Journal of Research in Personality, 50,* 66-70.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of personality assessment, 49,* 71-75.

Dunlop, W. L., & Tracy, J. L. (2013). Sobering stories: Narratives of self-redemption predict behavioral change and improved health among recovering alcoholics. Journal of Personality and Social Psychology, 104, 576.

Fivush, R. (2011). The development of autobiographical memory. *Annu Rev Psychol, 62,* 559-582.

Fivush, R., Booker, J. A., & Graci, M. E. (2017). Ongoing Narrative Meaning-Making Within Events and Across the Life Span. *Imagination, Cognition and Personality, 37,* 127-152.

Fivush, R., & Graci, M.E. (2017) Autobiographical Memory. In: Wixted, J.T. (ed.), Cognitive Psychology of Memory, Vol. 2 of Learning and Memory: A Comprehensive Reference, 2nd edition, Byrne, J.H. (ed.). pp. 119–135. Oxford: Academic Press.

Friedman, H. S., & Kern, M. L. (2014). Personality, well-being, and health. *Annual review of psychology*, *65*, 719-742.

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *359*, 1367-1378.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why?. *Current Directions in Psychological Science*, *13*, 1-4.

Graci, M. E., & Fivush, R. (2017). Narrative meaning making, attachment, and psychological growth and stress. *Journal of Social and Personal Relationships*, *34*, 486-509.

Graci, M. E., Watts, A. L., & Fivush, R. (2018). Examining the factor structure of narrative meaning-making for stressful events and relations with psychological distress. *Memory*, 1-13.

Grysman, A. (2015). Collecting narrative data on Amazon's Mechanical Turk. *Applied Cognitive Psychology*, *29*, 573-583.

Harris, A. H., Thoresen, C. E., Humphreys, K., & Faul, J. (2005). Does writing affect asthma? A randomized trial. *Psychosomatic Medicine*, *67*, 130-136.

Horowitz, M. J. (1975). Intrusive and repetitive thoughts after experimental stress: A summary. *Archives of general psychiatry*, *32*, 1457-1463.

Horowitz, M. J. (1993). Stress-response syndromes. In *International handbook of traumatic stress syndromes* (pp. 49-60). Springer US.

Kafka, G. J., & Kozma, A. (2002). The construct validity of Ryff's scales of psychological well-being (SPWB) and their relationship to measures of subjective well-being. *Social Indicators Research*, *57*, 171-190.

Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: a latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General*, *133*, 189-217.

King, L. A., Heintzelman, S. J., & Ward, S. J. (2016). Beyond the search for meaning: A contemporary science of the experience of meaning in life. *Current Directions in Psychological Science*, *25*, 211-216.

King, L. A., & Raspin, C. (2004). Lost and Found Possible Selves, Subjective Well-Being, and Ego Development in Divorced Women. *Journal of Personality, 72*, 603-632.

King, L. A., Scollon, C. K., Ramsey, C., & Williams, T. (2000). Stories of life transition: Subjective well-being and ego development in parents of children with Down syndrome. *Journal of Research in Personality, 34*, 509-536.

Klein, K., & Boals, A. (2001). Expressive writing can increase working memory capacity. *Journal of Experimental Psychology: General*, *130*, 520-533.

Klein, K., & Boals, A. (2010). Coherence and narrative structure in personal accounts of stressful experiences. *Journal of Social and Clinical Psychology*, *29*, 256-280.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest: tests in Linear mixed effects models. R package version 2.0–33. 2016.

Lilgendahl, J. P., & McAdams, D. P. (2011). Constructing stories of self-growth: How individual differences in patterns of autobiographical reasoning relate to well-being in midlife. *Journal of Personality, 79*, 391-428.

Litman, L., Robinson, J., & Abberbock, T. (2016). TurkPrime. com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods*,1-10.

Lodi-Smith, J., Geise, A. C., Roberts, B. W., & Robins, R. W. (2009). Narrating personality change. Journal of Personality and Social Psychology, 96(3), 679-689.

Ludecke, D., & Schwemmer, C. (2017). sjPlot: Data visualization for statistics in social science (version 2.3. 1)(software).

Lyubomirsky, S., Sousa, L., & Dickerhoof, R. (2006). The costs and benefits of writing, talking, and thinking about life's triumphs and defeats. *Journal of Personality and Social Psychology, 90*, 692.

Mansfield, C., Pasupathi, M., & McLean, K. (2015). Developing through difficulty: Does narrating growth of self in stories of transgressions promote self-acceptance and self-compassion? University of Utah: Salt Lake City.

McAdams, D. P. (2006). The problem of narrative coherence. *Journal of constructivist psychology*, *19*, 109-125.

McAdams, D. P. (2008). Personal narratives and the life story. *Handbook of personality: Theory and research*, *3*, 242-262.

McAdams, D. P., Bauer, J. J., Sakaeda, A. R., Anyidoho, N. A., Machado, M. A., Magrino-Failla, K., ... & Pals, J. L. (2006). Continuity and change in the life story: A longitudinal study of autobiographical memories in emerging adulthood. *Journal of personality*, *74*, 1371-1400.

McAdams, D. P., Reynolds, J., Lewis, M., Patten, A. H., & Bowman, P. J. (2001). When bad things turn good and good things turn bad: Sequences of redemption and contamination in life narrative and their relation to psychosocial adaptation in midlife adults and in students. *Personality and Social Psychology Bulletin*, *27*, 474-485.

McLean, K. C., Pasupathi, M., & Pals, J. L. (2007). Selves creating stories creating selves: a process model of self-development. *Pers Soc Psychol Rev*, *11*, 262-278.

McLean, K. C., & Pratt, M. W. (2006). Life's little (and big) lessons: identity statuses and meaning-making in the turning point narratives of emerging adults. *Developmental psychology*, *42*, 714-722.

Mikulincer, M., & Shaver, P. R. (2007). *Attachment in adulthood: Structure, dynamics, and change*. Guilford Press.

Oppenheimer, D. M., Meyvis, T., & Davidenko, N. (2009). Instructional manipulation checks: Detecting satisficing to increase statistical power. *Journal of Experimental Social Psychology, 45,* 867-872.

Pals, J. L. (2006). Narrative identity processing of difficult life experiences: pathways of personality development and positive self-transformation in adulthood. *J Pers, 74,* 1079-1109.

Pasupathi, M., & Hoyt, T. (2010). Silence and the shaping of memory: How distracted listeners affect speakers' subsequent recall of a computer game experience. *Memory, 18,* 159-169.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science, 8,* 162-166.

Pennebaker, J. W., & Chung, C. (2011). Expressive writing and its links to mental and physical health. *Oxford handbook of health psychology*, 417-437.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.

Reese, E., Haden, C. A., Baker-Ward, L., Bauer, P., Fivush, R., & Ornstein, P. A. (2011). Coherence of personal narratives across the lifespan: A multidimensional model and coding method. *Journal of Cognition and Development, 12,* 424-462.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual review of psychology, 52,* 141-166.

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of personality and social psychology, 57,* 1069.

Scheier, M. F., & Carver, C. S. (1985). Optimism, coping, and health: assessment and implications of generalized outcome expectancies. *Health psychology, 4*, 219-247.

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. Oxford university press.

Tavernier, R., & Willoughby, T. (2012). Adolescent turning points: the association between meaning-making and psychological well-being. *Developmental Psychology, 48*, 1058.

Team, R. S. (2015). R-Studio: integrated development for R. R-Studio, Inc., Boston, MA, USA.

Unsworth, N. (2010). Interference control, working memory capacity, and cognitive abilities: A latent variable analysis. *Intelligence, 38*, 255-267.

Walker, B. L., Nail, L. M., & Croyle, R. T. (1999, July). Does emotional expression make a difference in reactions to breast cancer?. In *Oncology nursing forum* (Vol. 26, No. 6, pp. 1025-1032).

Ware, J. E., Keller, S. D., & Kosinski, M. (1995). *SF-12: How to score the SF-12 physical and mental health summary scales*. Health Institute, New England Medical Center.

Waters, T. E., Bohanek, J. G., Marin, K., & Fivush, R. (2013). Null's the word: A comparison of memory quality for intensely negative and positive events. *Memory, 21*, 633-645.

Waters, T. E., & Fivush, R. (2015). Relations between narrative coherence, identity, and psychological well-being in emerging adulthood. *Journal of personality, 83*, 441-451.

Waters, T. E., Köber, C., Raby, K. L., Habermas, T., & Fivush, R. (2018). Consistency and stability of narrative coherence: An examination of personal narrative as a domain of adult personality. *Journal of personality*, 1-12.

Waters, T. E., Shallcross, J. F., & Fivush, R. (2013). The many facets of meaning making: Comparing multiple measures of meaning making and their relations to psychological distress. *Memory, 21*, 111-124.

Table 1

Demographic Descriptions for Time 1 and Time 5 Participants

Demographics		
	Time 1	Time 5
Age		
mean	24.39	24.52
SD	2.67	2.68
range	18–29	18–29
Gender		
Male	40%	38%
Female	60%	62%
Income		
$0-9,275	30%	29%
$9,276-37,650	42%	42%
$37,651-91,150	27%	28%
$90,150	1%	1%
Education		
Some high school	1%	1%
High school	9%	9%
Associates/technical college degree	15%	15%
Some college education	32%	31%
College degree	36%	35%
Post graduate degree	7%	9%
Ethnicity		
Caucasian	67%	62%
Black/African American	11%	11%
Hispanic/Latin-American	9%	16%
Asian/Asian-American	6%	9%
Multi-racial	5%	1%
Native American/American Indian	1%	0%
Another ethnicity	1%	1%

Table 2

Data Collection Across Time-points

Time 1 *(Baseline)*	*Time 2* *(Week 1)*	*Time 3* *(Week 2)*	*Time 4* *(Week 3)*	*Time 5* *(Week 7)*
Health Indices	Health Indices	Health Indices	Health Indices	Health Indices
Narratives	Narratives	Narratives	Narratives	Narratives
Demographics				
Personality Factors				
Cognitive Factors				

Table 3

Narrative Coding Schemes

Structural Themes	Description	Reliability Statistic
Context	The narrator places the story in both time and place. Specificity of time includes dates or autobiographical moments (e.g., my first time flying on a plane). Specificity of location includes descriptions of physical locations. Low scorers have neither time nor place in their story.	ICC = .946
Chronology	Naïve listener can order almost all (> 75%) of the temporally relevant actions. Low scorers tell their stories in a disorderly and hard to discern manner.	ICC = .915
Theme	Narrative includes all the above and a resolution to the story, or links to other autobiographical experiences including future occurrences, or self-concept or identity. Low scorers do not elaborate beyond the facts of the experience.	ICC = .934
Meaning-Meaning Themes		
Growth	Higher scored narratives include how the event helped the person develop a better sense of self. Lower scored narratives include how the event inhibited a better sense of self.	ICC = .903

Table 4

Descriptives for all time-varying measures

Variable	*n*	*M*	*SD*	*Min-Max*
Well-being (Baseline)	297	76.36	11.66	41-103
Well-being (week 1)	238	77.56	12.04	35-103
Well-being (week 2)	218	78.56	12.07	42-104
Well-being (week 3)	195	78.14	13.14	35-104
Well-being (week 7)	185	77.95	13.25	38-105
Life Satisfaction (Baseline)	298	22.20	7.02	5-35
Life Satisfaction (week 1)	241	22.76	7.02	5-35
Life Satisfaction (week 2)	220	22.91	7.24	5-35
Satisfaction (week 3)	195	23.23	7.17	5-35
Life Satisfaction (week 7)	185	23.69	7.22	5-35
Stress (Baseline)	296	17.43	7.97	0-35
Stress (week 1)	238	16.61	7.85	0-38
Stress (week 2)	220	15.23	7.83	0-33
Stress (week 2)	197	15.13	8.57	0-40
Stress (week 7)	184	16.11	8.46	0-35
Physical health (Baseline)	299	16.70	2.56	6-20
Physical health (week 1)	242	16.84	2.67	7-20
Physical health (week 2)	220	16.99	2.64	6-20
Physical health (week 3)	196	17.11	2.87	6-20
Physical health (week 7)	186	17.19	2.71	6-20
Negative Event Growth (Baseline)	300	2.14	1.06	1-5
Negative Event Growth (week 1)	242	2.27	1.12	1-5
Negative Event Growth (week 2)	220	2.32	1.03	1-5
Negative Event Growth (week 3)	197	2.45	1.14	1-5
Negative Event Growth (week 7)	186	2.44	1.16	1-5
Positive Event Growth (Baseline)	300	4.23	0.73	1-5
Positive Event Growth (week 1)	241	4.09	0.71	2-5
Positive Event Growth (week 2)	220	4.04	0.76	2-5
Positive Event Growth (week 3)	197	4.04	0.77	1-5
Positive Event Growth (week 7)	186	4.03	0.73	1-5
Negative Event Coherence (Baseline)	300	6.72	1.90	1-9
Negative Event Coherence (week 1)	242	5.84	2.29	0-9
Negative Event Coherence (week 2)	220	5.64	2.37	0-9
Negative Event Coherence (week 3)	197	5.72	2.31	0-9
Negative Event Coherence (week 7)	186	5.70	2.41	0-9
Positive Event Coherence (Baseline)	300	6.73	2.03	0-9
Positive Event Coherence (week 1)	241	5.96	2.24	0-9
Positive Event Coherence (week 2)	220	5.93	2.43	0-9
Positive Event Coherence (week 3)	197	5.80	2.29	0-9
Positive Event Coherence (week 7)	186	5.87	2.44	0-9

Table 5

Descriptives for all covariate measures

Variable	*N*	*M*	*SD*	*Min-Max*
Negative event time since event (years)	300	6.35	5.14	0.00-27.92
Positive event time since event (years)	300	4.17	4.25	0.00-27.92
Neuroticism	299	26.73	8.93	5.00-48.00
Extraversion	298	26.66	6.69	8.00-44.00
Openness	296	32.85	6.37	17.00-47.00
Agreeableness	297	32.36	5.40	15.00-45.00
Conscientiousness	297	33.41	6.99	14.00-48.00
Verbal ability	300	9.14	3.75	1.00-17.00
Negative Event Writing Time (Baseline)	300	536.09	384.89	12.45-3149.56
Negative Event Writing Time (week 1)	242	440.18	317.04	12.14-2237.55
Negative Event Writing Time (week 2)	220	452.88	367.91	10.60-3121.19
Negative Event Writing Time (week 3)	197	393.80	282.63	8.03-1645.21
Negative Event Writing Time (week 7)	186	441.02	348.81	7.66-2306.48
Positive Event Writing Time (Baseline)	300	491.70	349.96	10.06-3053.29
Positive Event Writing Time (week 1)	241	489.94	499.74	14.72-4785.33
Positive Event Writing Time (week 2)	220	454.85	415.34	8.81-2505.78
Positive Event Writing Time (week 3)	197	427.27	477.56	7.44-4338.25
Positive Event Writing Time (week 7)	186	441.88	412.51	13.44-2574.54

Table 6

Narrative Topics for all 300 participants at time 1

Event Categories	Event Type	
	Negative	Positive
Interpersonal relationships	37.33%	50.00%
Achievements/failures	3.33%	29.67%
Death/loss	21.33%	0.00%
Serious illness or injury	17.33%	0.00%
Sexual violence/abuse	12.33%	0.00%
Self-improvement	0.00%	7.33%
Other	8.33%	13.00%

Table 7

Correlations between all baseline measures

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Well-being																	
2. Life Satisfaction	.61**																
3. Stress	-.57**	-.60**															
4. Physical health	.47**	.36**	-.45**														
5. Negative Event Coherence	.23**	.07	-.03	.07													
6. Positive Event Coherence	.21**	-.01	-.01	.03	.52**												
7. Negative Event Growth	.14*	.13*	-.13*	.16**	.02	-.03											
8. Positive Event Growth	.17**	.08	-.16**	.04	.21**	.25**	.04										
9. Neuroticism	-.61**	-.54**	.73**	-.45**	.02	.03	-.20**	-.06									
10. Extraversion	.46**	.40**	-.37**	.27**	-.02	-.09	.15**	.04	-.53**								
11. Openness	.29**	-.02	-.01	-.00	.22**	.13*	-.05	.10	.05	.02							
12. Agreeableness	.50**	.23**	-.30**	.25**	.14*	.12*	.04	.03	-.30**	.34**	.23**						
13. Conscientiousness	.68**	.41**	-.45**	.40**	.14*	.12*	.15**	.09	-.47**	.39**	.18**	.45**					
14. Time Since Negative Event	.12*	.12*	-.10	.04	.08	-.01	-.00	.04	-.06	-.00	.12*	.13*	.08				
15. Time Since Positive Event	-.04	-.09	.11	-.08	-.05	-.09	-.06	.00	.06	-.07	.03	-.03	-.03	.22**			
16. Time Writing Negative Event	.12*	.01	-.02	.10	.36**	.27**	.01	.08	.03	-.02	.23**	.07	.08	.09	-.06		
17. Time Writing Positive Event	.17**	.04	-.08	.12*	.32**	.26**	-.03	.11*	-.07	-.04	.13*	.03	.13*	.05	-.03	.38**	
18. Verbal ability	.23**	.01	-.08	.09	.35**	.37**	-.09	.11	.06	-.12*	.44**	.18**	.09	.07	.02	.24**	.26**

Note. * indicates $p < .05$. ** indicates $p < .01$.

Table 8

HLM Model 1 for Psychological-well-being

	Well-being				
Fixed Effects	*b*	*se*	*LCI*	*UCI*	*p*
(Intercept)	37.08	5.55	26.17	47.99	**< .001**
Time-Varying Variables					
Time	0.07	0.07	-0.07	0.21	0.331
Negative Event Coherence	0.15	0.09	-0.03	0.33	0.109
Positive Event Coherence	0.17	0.09	-0.02	0.35	0.078
Negative Event Growth	0.13	0.14	-0.15	0.41	0.368
Positive Event Growth	-0.12	0.24	-0.59	0.35	0.616
Negative Event Writing Time	0.00	0.00	0.00	0.00	0.721
Positive Event Writing Time	0.00	0.00	0.00	0.00	0.465
Time-invariant Variables					
Verbal Ability	0.35	0.12	0.12	0.58	**0.003**
Neuroticism	-0.49	0.06	-0.6	-0.38	**< .001**
Extraversion	0.18	0.07	0.04	0.320	**0.010**
Openness	0.32	0.07	0.19	0.46	**0.000**
Agreeableness	0.17	0.08	0	0.33	**0.047**
Conscientiousness	0.60	0.07	0.47	0.73	**< .001**
Negative Event Retention Interval	0.01	0.08	-0.13	0.16	0.847
Positive Event Retention Interval	-0.05	0.10	-0.23	0.14	0.635
Gender	2.44	0.81	0.84	4.05	**0.003**
Age	0.17	0.15	-0.13	0.46	0.261
Income	0.75	0.54	-0.31	1.81	0.167
Education	-0.01	0.36	-0.72	0.70	0.983
Random Parts					
σ^2	15.090				
$\tau_{00,\ ID}$	31.034				
ρ_{01}	0.511				
N_{ID}	281				
ICC_{ID}	0.673				
Observations	1066				
R^2 / Ω_0^2	.929 / .929				

Note. Confidence intervals were set at 95%. Bolded *p*-values denote $p < .05$.

Table 9

HLM Model 2 for Life Satisfaction

	Life Satisfaction				
Fixed Effects	*b*	*se*	*LCI*	*UCI*	*p*
(Intercept)	21.15	4.76	11.79	30.52	**< .001**
Time-varying Variables					
Time	0.12	0.04	0.03	0.21	**0.008**
Negative Event Coherence	-0.04	0.06	-0.15	0.07	0.444
Positive Event Coherence	0.13	0.06	0.02	0.24	**0.024**
Negative Event Growth	0.11	0.09	-0.06	0.28	0.218
Positive Event Growth	0.02	0.15	-0.27	0.30	0.914
Negative Event Writing Time	0.00	0.00	0.00	0.00	0.541
Positive Event Writing Time	0.00	0.00	0.00	0.00	0.138
Time-Invariant Variables					
Verbal Ability	0.06	0.10	-0.14	0.26	0.559
Neuroticism	-0.30	0.05	-0.40	-0.21	**< .001**
Extraversion	0.11	0.06	0.00	0.23	0.059
Openness	-0.07	0.06	-0.18	0.05	0.245
Agreeableness	-0.06	0.07	-0.20	0.08	0.400
Conscientiousness	0.15	0.06	0.04	0.27	**0.007**
Negative Event Retention Interval	0.06	0.06	-0.07	0.19	0.335
Positive Event Retention Interval	-0.20	0.08	-0.36	-0.04	**0.014**
Negative Event Writing Time	0.00	0.00	0.00	0.00	0.541
Positive Event Writing Time	0.00	0.00	0.00	0.00	0.138
Gender	0.67	0.70	-0.70	2.05	0.335
Age	0.06	0.13	-0.19	0.31	0.645
Income	0.56	0.46	-0.35	1.47	0.225
Education	0.30	0.31	-0.31	0.90	0.339
Random Parts					
σ^2	4.997				
$\tau_{00,\ ID}$	27.342				
ρ_{01}	-0.135				
N_{ID}	280				
ICC_{ID}	0.845				
Observations	1070				
R^2 / Ω_0^2	.936 / .935				

Table 10

HLM Model 3 for Perceived Stress

	Perceived Stress				
Fixed Effects	*b*	*se*	*LCI*	*UCI*	*p*
(Intercept)	15.22	4.22	6.88	23.53	< **.001**
Time-varying Variables					
Time	-0.08	0.08	-0.25	0.08	0.304
Negative Event Coherence	0.03	0.10	-0.16	0.23	0.726
Positive Event Coherence	0.00	0.10	-0.20	0.20	0.976
Negative Event Growth	-0.46	0.16	-0.77	-0.14	**0.004**
Positive Event Growth	-0.17	0.26	-0.69	0.34	0.509
Negative Event Writing Time	0.00	0.00	0.00	0.00	0.604
Positive Event Writing Time	0.00	0.00	0.00	0.00	**0.050**
Time-invariant Variables					
Verbal Ability	-0.20	0.09	-0.37	-0.02	**0.027**
Neuroticism	0.50	0.04	0.42	0.59	< **.001**
Extraversion	0.02	0.05	-0.08	0.13	0.648
Openness	-0.05	0.05	-0.15	0.05	0.310
Agreeableness	-0.04	0.06	-0.16	0.08	0.532
Conscientiousness	-0.14	0.05	-0.23	-0.04	**0.006**
Negative Event Retention Interval	-0.07	0.05	-0.18	0.04	0.184
Positive Event Retention Interval	0.16	0.07	0.02	0.30	**0.022**
Gender	0.29	0.60	-0.90	1.48	0.632
Age	-0.07	0.11	-0.29	0.15	0.525
Income	0.44	0.40	-0.34	1.22	0.271
Education	-0.23	0.26	-0.76	0.29	0.380
Random Parts					
σ^2	19.452				
$\tau_{00,\ ID}$	13.244				
ρ_{01}	0.036				
N_{ID}	279				
ICC_{ID}	0.405				
Observations	1065				
R^2 / Ω_0^2	.790 / .782				

Table 11

HLM Model 4 for Physical Health

	Physical Health				
Fixed Effects	*b*	*se*	*LCI*	*UCI*	*p*
(Intercept)	14.22	1.78	10.71	17.74	< **.001**
Time-varying Variables					
Time	0.03	0.02	0.00	0.07	0.054
Negative Event Coherence	0.03	0.03	-0.03	0.08	0.309
Positive Event Coherence	0.03	0.03	-0.02	0.09	0.251
Negative Event Growth	0.06	0.04	-0.02	0.15	0.134
Positive Event Growth	0.06	0.07	-0.08	0.20	0.399
Negative Event Writing Time	0.00	0.00	0.00	0.00	0.194
Positive Event Writing Time	0.00	0.00	0.00	0.00	0.720
Time-invariant Variables					
Verbal Ability	0.08	0.04	0.01	0.16	**0.028**
Neuroticism	-0.07	0.02	-0.10	-0.03	< **.001**
Extraversion	0.00	0.02	-0.05	0.04	0.843
Openness	-0.01	0.02	-0.05	0.03	0.680
Agreeableness	0.02	0.03	-0.03	0.08	0.396
Conscientiousness	0.09	0.02	0.05	0.13	< **.001**
Negative Event Retention Interval	-0.01	0.02	-0.06	0.04	0.630
Positive Event Retention Interval	-0.04	0.03	-0.10	0.02	0.156
Negative Event Writing Time	0.00	0.00	0.00	0.00	0.194
Positive Event Writing Time	0.00	0.00	0.00	0.00	0.720
Gender	-0.06	0.26	-0.57	0.46	0.821
Age	-0.03	0.05	-0.12	0.07	0.558
Income	0.28	0.17	-0.06	0.62	0.104
Education	0.03	0.12	-0.21	0.26	0.812
Random Parts					
σ^2	1.353				
$\tau_{00,\ ID}$	3.411				
ρ_{01}	0.263				
N_{ID}	281				
ICC_{ID}	0.716				
Observations	1073				
R^2 / Ω_0^2	.857 / .854				

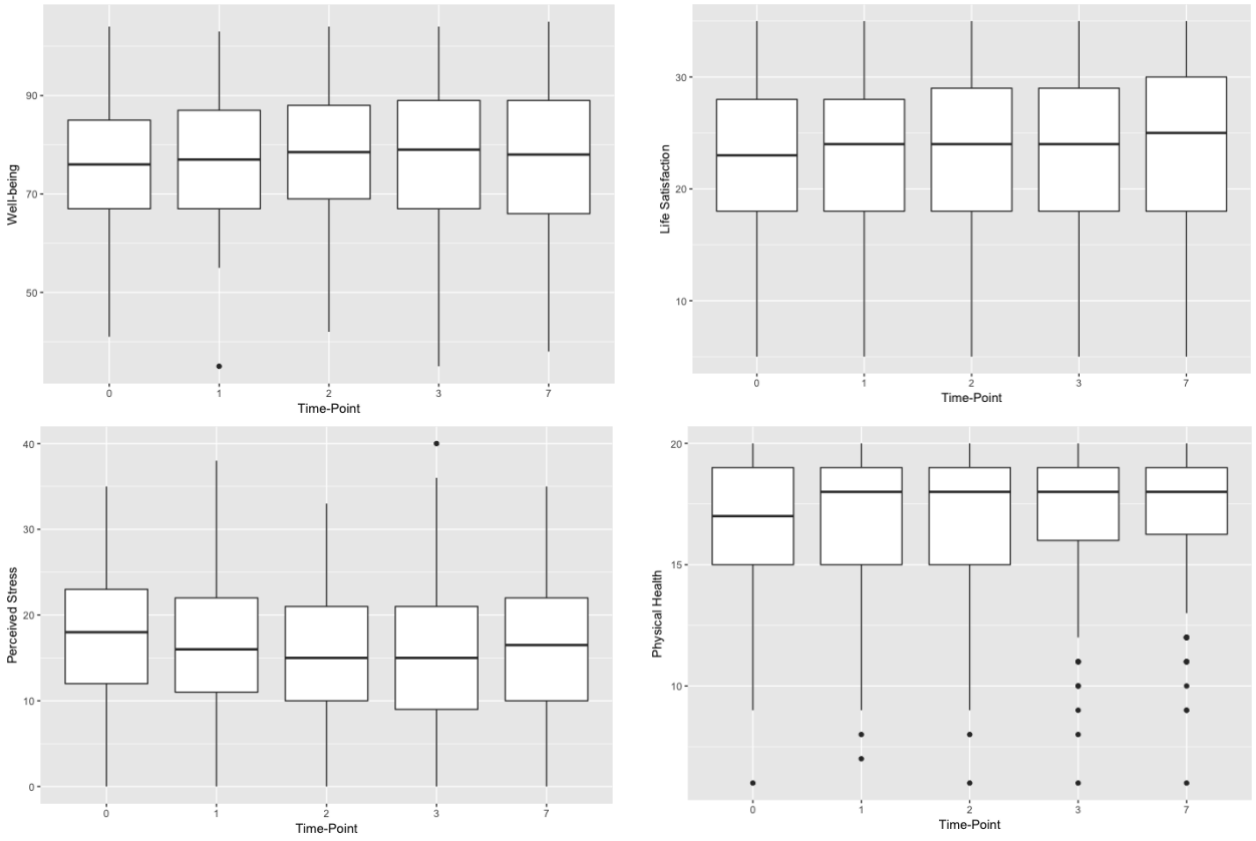

Figure 1. Boxplots for all health measures.

Appendix A
Narrative Scoring Examples

Narrative Scoring	Example
Growth	
Low Score	The most negative experience of my life so far has been my grandmother dying unexpectedly. The phone call we got that she was in the hospital was out of the blue and I wasn't prepared. Since then I haven't been quite the same. I'm worried a lot more now that she got taken away. I worry about my own mother dying more often now. I'm scared of being alone, and it has greatly impacted me negatively since it happened a few years ago.
High Score	The most negative experience in my life would be my first marriage. She ended being a totally different person than what I had dated, prior to the marriage. I felt trapped at first, but then realized that life was just too short for this and that I had to make a change for my own happiness. Basically, she ended up cheating on me. The reason this was so negative for me was because I thought I knew her. I thought she wanted to be with me. Why else would you get married to someone? To have the one person that you trusted and loved stab you in the back is about as negative as it gets. I learned a lot from this experience though and look back on in kind of laughing. I was so young and so stupid to fall for a person like her. I still didn't deserve what she did, but I was still naive.
Coherence	
Low Score	One of the most negative experiences of my life was when my parents announced they were getting divorced. It put a pit in my stomach. I couldn't breath and it felt like I was in shell shock. It was so out of the blue that I had no idea how to process it. It felt like someone had died. I felt like crying and running away. I was just in so much shock that I just sat there, with no idea what to do or say.
High Score	After my first semester of graduate school, I flew back to join my girlfriend for winter break. It was a big relief to see her and my dog again. For the next month, I felt like I had the summer before I left: free, relaxed, and happy with my best friend. We got to do all of the normal things again (e.g., make breakfast, try new foods, run together) and finally get a break from the stress of long distance relationships. I was happy to do anything to help her out as she had been very busy with an internship and trying to care for our dog at the same time. The whole situation was a big relief because, back at school, I felt like l could never fully relax (i.e., bike getting stolen) and always feared that something might have happened to my car each time I walked to it. Additionally, I got to see my family again and, of course, they were happy to see me too.

Appendix B
HLM Model Equations

Lower-Level Equation:

$Outcome_{ti} = \pi_{0i} + \pi_{1i}(time_{ti}) + \pi_{2i}(\text{Negative Event Coherence}_{ti}) + \pi_{3i}(\text{Positive Event Coherence}_{ti}) + \pi_{4i}(\text{Negative Event Growth}_{ti}) + \pi_{5i}(\text{Positive Event Growth}_{ti}) + \pi_{6i}(\text{Negative Event Writing Time}_{ti}) + \pi_{7i}(\text{Positive Event Writing Time}_{ti}) + r_{ti}$

Upper-Level Equations:

$\pi_{0i} = \beta_{00} + \beta_{01}(Verbal\ Ability_i) + \beta_{02}(\text{Neuroticism}_i) + \beta_{03}(\text{Extraversion}_i) + \beta_{04}(\text{Openness}_i) + \beta_{05}(\text{Agreeableness}_i) + \beta_{06}(\text{Conscientiousness}_i) + \beta_{07}(\text{Negative Event Retention Interval}_i) + \beta_{07}(\text{Positive Event Retention Interval}_i) + \beta_{07}(\text{Gender}_i) + \beta_{08}(\text{Age}_i) + \beta_{09}(\text{Income}_i) + +\beta_{010}(\text{Education}_i) + \mu_{0i}$

$\pi_{1i} = \beta_{10} + \mu_{1i}$

An Automated Approach for Assessing the Semantic Coherence of Personal Narratives

Matthew E. Graci

Emory University

Abstract

The present research investigated the extent implementing a machine learning algorithm can derive a new indicator of narrative coherence that provides insights into the construct of coherence. The present research utilized a neural network to measure the semantics between millions of English words, and then further implemented the measure to assess the semantic coherence of individuals' personal stories. Across two studies, the newly developed automated semantic coherence measure was examined in relation to hand-coded structural coherence to investigate the viability of the semantic measure as an indicator of narrative coherence. In Study 1, 224 undergraduates (m_{age} = 19.2, SD_{age} = 2.1, 49% self identified females) wrote about the most positive and negative events of their lives. The newly developed semantic coherence measure had a curvilinear relation to structural coherence in both positive and negative event narrative samples. In Study 2, 300 community sample participants (m_{age} = 24.7 .2, SD_{age} = 2.7; 60% self identified females) wrote about the most positive and negative events of their lives, as well as completed a series of psychological health indices. Again, the semantic coherence measure had a curvilinear relation to structural coherence in both positive and negative event narrative samples, and both indicators of coherence significantly explained levels of higher well-being. There appears to be an optimal level of semantic coherence that relates with higher structurally coherent narratives and levels of well-being. We can capitalize on the hard-to-identify underlying statistics of language usage to better understand how people share their personal stories.

An Automated Approach for Assessing the Semantic Coherence of Personal Narratives

There is a general consensus that coherence of people's personal narratives is healthy for them, yet there is a lack of consensus among researchers on how narrative coherence is defined (McAdams, 2006). Further, the relations between coherence measures and psychological health are surprisingly mixed. Thus, there is a great need to better understand the underlying construct of narrative coherence in order to further elucidate why it matters for psychological health, defined here as: psychological well-being, life satisfaction, and perceived stress. Assessing additional indicators of coherence can help us specify how the complex structural and semantic components of narrative coherence relate to psychological health with greater clarity. More specifically, implementing an automated semantic coherence measure to assess hard-to-identify semantics of personal narratives can provide theoretical and methodological specificity to the construct and its relation to psychological health.

Coherence of personal stories is most commonly measured by three dimensions: theme, context, and chronology. In general, the more people theme their experiences with an elaborated plot, contextualize them in place and time, and order the experience in a chronological manner, the more coherent their narratives are (Reese, Haden, Baker-Ward, Bauer, Fivush, & Orstein, 2011). These dimensions of coherence measure the order—or organization—of a personal experience, both internal to that experience and in relation to other life experiences; thus, they are said to measure the structure of narratives. Creating coherent structure to one's personal stories generally represents a healthy type of meaning-making, because it helps create a sense of order to one's internal dynamics (e.g., thoughts and feeling) and the external dynamics (e.g. actions and environment; McAdams & McLean, 2013).

However, sharing a well-structured personal narrative might not always be associated with positive psychological health. On the one hand, a number of studies show that more coherent narratives are related to *higher* psychological well-being (Baerger & McAdams, 1999; Waters & Fivush, 2015). On the other hand, other studies show that more coherent narratives relate to *lower* well-being and higher stress (McLean, Breen, & Fournier, 2010; Sales, Merrill, & Fivush, 2013; Waters, Shallcross, & Fivush, 2013). Individuals experiencing different developmental stages (e.g., young adolescents) or environmental factors (e.g., chronic stressors) demonstrate a negative association between narrative structure and psychological health—one in which greater narrative structure may exacerbate negative psychological health. A deeper understanding of the construct of coherence may help further elucidate discrepant findings.

In particular, measuring the relationships between different words to assess the compositionality of the content—the semantics of the narratives—can likely enhance the understanding of how narrative coherence relates to psychological health. Unlike structural coherence, which assesses the organization or structure of the narrative, semantic coherence putatively assesses the extent to which the meaning conveyed across the narrative is coherent. Thus, the first major objective of this study is to assess and compare structural and semantic forms of coherence in personal narratives.

Computerized approaches have already demonstrated their capability to capture the hard-to-identify semantics of language usage. One underlying assumption to the computerized semantic approach is that there are statistical properties to the words people choose to say, which can be represented in high dimensional space. For example, in the *distributional hypothesis,* synonyms can be operationalized as its probabilities of occurring around the same words (Firth, 1957). For example, verbs like “jogged”, “ran”, “sprinted” are all more likely to occur around

words “around the race track”, compared to “wrote”, “penned” or “composed”. When words are analyzed as their statistics—their probabilities of occurring in certain linguistic contexts (i.e., sentences) given its probabilities of occurring in all contexts—they can be used to predict psychological symptomology, like depression levels (Takano, Ueno, Moriyam, Mori, Nishiguchi, & Raes, 2016), and even psychological disorder diagnosis (Bedi et al., 2015). The next step in this approach is to increasingly move beyond measuring the word-level statistics to measuring the semantics between sentences, and then the semantics of entire personal stories. Thus, the second major objective of this study is to implement an automated measure that captures hard-to-identify semantic coherence across entire personal narratives in relation to psychological health.

In summary, in two studies, the present research compares hand-coded structural coherence with newly developed machine learning algorithms to assess semantic coherence utilizing the distributional hypothesis. The two overarching motivations for this study are to measure hard-to-identify semantics of personal stories, as well as to provide theoretical and methodological specificity to the construct of narrative coherence and its relations to psychological health. These overarching motivations lay the ground work for the two objectives of the study: 1) assessing associations with hand-coded structural coherence; and 2) assessing associations with psychological health. If there are positive linear relations between structural and semantic coherence, then the two measures might be tapping the *same* indicator of coherence. In principal, if the semantic measure can increasingly explain more variance in structure, then there is more to be learned about the subtle sub-components of coherence and its relationships to psychological health. If there are non-linear relationships between structural and semantic coherence, then the two measures might be tapping *different* indicators of coherence. In

principal, if the semantic measures demonstrate an optimal level of coherence, then we are learning more about several indicators of coherence and how they collectively relate to psychological health. Each type of association can be used to reflexively understand the construct of coherence. Thus, as objective one, hand-coded structural coherence can be used as a ground truth measure to help determine convergent validity for automated semantic coherence. As objective two, once the proof-of-concept for the semantic coherence measure is deemed viable, it should be replicable and extend to measure linear and/or curvilinear relationships with psychological health in another sample, as carried out in study 2.

Study 1

There is more to the construct of coherence that can be fully captured by one indicator. The semantic components of narrative coherence in addition to the structural components of narrative coherence. In study 1, an automated measure will be created to putatively capture semantic coherence by implementing a machine learning algorithm. Then the measurement will be examined in relation to hand-coded structural coherence to investigate convergent validity.

The ability to create automated semantic measures has already been established. In particular, Bedi and colleagues (2015) successfully identified individuals who did or did not go on to develop schizophrenia as well as trained clinicians did by using automated methods to assess semantic coherence. They did so by creating a measurement that quantified how similar words co-occurred in texts using Latent Semantic Analysis (LSA). LSA is a high dimensional associative model that indexes each word in the lexicon with a vector space based on its semantic content. They used LSA to assess the minimum semantic distance between sentences (i.e., a maximum discontinuity in the text) and its average semantic coherence across all sentences. Both measures were significantly negatively correlated with disorder: lower semantic coherence

means higher likelihood of schizophrenia, confirming hand-coded and clinical observation that established that severe disorder is consistently linked with low narrative coherence (Adler, Chin, Kolisetty, 2012). These findings suggest that there is an optimal level of semantic pacing throughout linguistic expression (i.e., moving the "plot" along in discernable ways) that healthy individuals inherently incorporate into their linguistic expression—and that schizophrenics struggle to employ in their expression (Buck & Penn, 2015). The present study further explores this notion of semantic pacing in personal narratives by measuring semantic coherence along a continuum in healthy individuals. Thus, the study utilizes a state-of-the-art semantic space to establish the semantic continuum and, by extension, semantic coherence.

The present study utilizes the Word2vec (W2V) neural network to capture the semantics of language (Mikolov, Sutskever, Chen, Corrado, & Dean, 2013). Broadly speaking, neural networks attempt to mimic brain operations by running a series of algorithms to identify relationships in a large set of data. Instead of predicting the activation of neurons, W2V identifies the relation between target words and their neighboring context words. If word A and B typically have almost identical neighboring words, they are most likely synonyms for each other. Thus, W2V can capitalize on *distributed semantics*, in which similar words tend to occur in similar places. W2V's neural network skip gram algorithm allows for the prediction of neighboring words by using the target word. These predictions are made using vectors spaces, a high dimensional point that is a series of positive point-wise mutual information (PPMI) measurements with other words. For example, running verbs like "run", "sprint", and "jog" all tend to have the same PPMI vectors. Mikolov and colleagues (Mikolov, Yih, Zweig, 2013) have demonstrated how W2V can be used to start deriving a strong sense of semantics based on how words are distributed together. For example, to obtain the vector space for the word "queen," one

can use the vector spaces for “king” - “man” + “woman.” W2V is an innovative tool because it can potentially measure the composability of concepts, such as kings and queens, and possibly help derive a level of semantic coherence in personal narratives.

Thus, study 1 creates a semantic coherence measure as a proof-of-concept indicator for semantic narrative coherence. The relationship between automated semantic coherence and hand-coded structural coherence will be assessed in order to establish a form of convergent validity to the underlying construct of coherence. Moreover, if the relationship between semantic coherence and structural coherence is present in one sample of personal narratives, the relationship should also be found in another sample of the same participants’ personal narratives. Thus, study 1 examines both negative and positive personal narratives from the same participants in order to determine the relationship between semantic and structural coherence.

Method

Data were collected as part of a parent study examining how people remember highly emotional experiences and its relations to individual differences. In total, 224 undergraduates completed the study (M_{age} = 19.2 years, SD_{age} = 2.1, 50.9% males and 49.1% females); 67.6% per cent of the participants self-identified as Caucasian, 11.6% as Asian, 7.6% as African-American, 3.6% as Indian, 2.2% as Hispanic and 7.1% as Mixed or Other origin. Participants received course credit for participation, and all procedures were approved by the university’s Institutional Review Board. Participants sat in a university classroom with six to eleven other participants, were spaced several seats apart, and completed a handwritten workbook. Participants had unlimited time to complete the workbook and took 90–120 min on average. In addition to narrative prompts, the workbook contained a battery of personality and individual difference questionnaires (see Waters, Bohanek, Marin, & Fivush, 2013, for more details).

The current study utilizes 2 of the 4 narrative prompts, the most traumatic and most positive experience prompts. The narrative writing prompt was adopted from the expressive writing literature (Pennebaker, 1997):

> I would like for you to write about your most traumatic [positive] experience of your life. This should be an extremely emotional event that has affected you and your life. You may include the facts of the event, as well as your deepest thoughts and feelings. All of your writing will be kept confidential. Do not worry about spelling, sentence structure, or grammar. There is no time limit on your writing; you may write about this event for as long as needed.

Narrative coding

Hand Coding. The human coding scheme was derived from Reese and colleagues construct of coherence (Reese et al., 2011), which is broken down into three domains: theme, context and chronology. Each dimension was coded on a 4-point scale, with 0 representing no coherence based on the dimension, and 3 exhibiting complete coherence based on the dimension.

Theme measures the extent a topic is elaborated in the narrative. Narratives substantially off topic are scored 0; narratives on topic but with only minimal elaboration or linkages between actions, thoughts, and/or feelings are scored 1; narratives with a substantially developed topic and connections between actions, thoughts, and/or feelings to previously reported actions are scored 2; and narratives including a resolution to the story and/or links to autobiographical experiences are scored 3.

Context measures to extent one provides the time and place of the experience. Narratives that do not mention of time nor place are scored 0; the mention of either general time (‘‘when I was younger’’) or place (“I was at school”) is scored 1; mention of either specific time (“Thanksgiving day last year”) or place (‘‘at my local grocery store) is scored 2; and mention of both specific place and time is scored 3.

Chronology measures of temporal ordering across the narrative. Narratives without any order of actions, or no actions at all, are scored 0; minimal or confusing ordering of most of actions are scored 1; over 50% of the actions can be adequacy tracked by the reader, but no more than 75% of the actions, are scored a 2; nearly all actions follow an orderly sequence and deviance from that orderly are marked as such, are scored a 3.

Each narrative coherence indicator was coded by two independent coders. All coders learned the specific coding scheme through reading and discussion of that coding manual. Then, the coders used a predetermined set of the narratives during the coding training phase. During this phase, the coders discussed each narrative code in depth. After training, a previously unexamined subset of narratives was coded independently by each coder in order to compute reliability. Reliability was established by two independent coders on a subset of 50 narratives for each coherence subscale: theme ($\alpha = .90$), context ($\alpha = .88$), and chronology ($\alpha = .94$). Please see Appendix A for examples of low and high coherence scores.

Automated Coding. The primary idea of the automated tool is that more coherent narratives have similar semantic adjacent sentences. The tool utilizes a word2vec (W2V) to create the semantic space, and then Euclidean distance to measure the distance between sentences. The New York Times was used as the word corpus to predict neighboring words. W2V's neural network's skip gram algorithm, shown in Figure 1, allows for the prediction of neighboring words by using the target word. These predictions are made using vector spaces, a high dimensional point that is a series of PPMI measurements with other words. Put another way, "rush" and "hurry" would have similar high dimensional coordinates because their vector spaces would consist of similar PPMI measurements that would predict similar neighboring words in a given sentence (e.g., "I had to [word] through the project"). Within this semantic

space of words, sentence representations were approximated by using the formula,

$L_i = \frac{1}{N}\sum_{k=1}^{N} l_{ik}$, average of N word vectors in a sentence from index k=1 to N was computed a sentence vector. Lastly, coherence was computed using the formula, $\{cos(L_i, L_{i+1})\}$, average sentence vectors were measured as the average cosine distance between adjacent sentences, which is effectively the similarity of all adjacent sentences. Please see Appendix B for examples of low and high coherence scores.

Importantly, similar to a reliability check in hand-coded scores, a manipulation check tool was created to help ensure the coherence measure was indeed tapping some dimension of narrative coherence. The sole function of the manipulation checking tool was to replace words in the narratives with random words. Put another way, if there were 100 words in the narrative and the manipulation checking tool was set to 10%, the manipulation checker would replace 10 of the words with random words. The random words were drawn from the brown corpus, which was created by Brown University in 1961. The brown corpus is an ideal corpus as the random pool of words to be replaced by the manipulation checker for the narrative dataset because much of this open source corpus was drawn from media sources, including news sources like the New York Times. All 221 narratives from the negative event were subjected to this randomization process, going from 0–100 percent random in increments of 5. At each increment of word randomness, all narrative scores were averaged for total automated score. Please see below for examples of the manipulation checking tool at varying degrees of randomness at work on a sample of a narrative:

> 0%: I have unfortunately experienced MANY traumatic events, all over time things that still occur or have affects today.
>
> 25%: I have unfortunately experienced MANY traumatic reflection, this over time really that still computer or have affects today.

50%: Rhode together unfortunately that MANY seemed events, all over time through I tank Order or have affects today.

The manipulation checker should produce a high negative correlation between more randomness in the narratives and lower average automated coherence scores. When performing the manipulation checking function on the dataset in increments of 5 (i.e., 5, 10, 15…. 100%), there was a robust negative correlation (r = -.80, p < .001). More randomness imposed of the narratives significantly decreased the automated scores for the narratives.

Data analytic plan

The data analysis objective was to use human-rated scores of coherence as ground truth for the automated scores. There were two steps to the data analysis plan to assess the relation between hand-coded and automated coherence: 1) basic correlations between the two measures; and 2) regressions assessing non-linear relations. Non-linear relations were assessed in the following manner: mean-centering the predictor to avoid collinearity issues (Cohen, Cohen, West, & Aiken, 2003), and then performing a hierarchical regression with the squared mean centered automated score in the second block of the regression. Non-linear relations were kept in the models when there was a significant change in variance explained.

Results

Descriptives. The most narrated topics for traumatic memories concerned Accidents/illnesses (54%) whereas the majority of the narrated positive memories concerned Achievement (56%). Please see Table 1 for more details on all narrated categories.

Preliminary Analyses

For descriptives and correlations on all narrative measures, please see Table 2. There was no significant relation between hand-coded coherence of negative events and automated coherence of negative events (r = .11, p = 0.099), nor a significant relation between hand-coded

and automated measures for positive events (r = -.02, p = 0.828). Automated coherence from negative events was positively correlated with automated coherence from positive events (r = .26, p < .001), which was similar to the relation between hand-coded measures for negative and positive events (r = .34, p < .001).

Regression diagnostics. All of the following regressions were checked for the assumptions of normality, homoscedasticity, collinearity, and nonlinearity, none of which were violated. Autocorrelations and outliers were also assessed. As a sensitivity check, regressions were run with and without outliers in the dataset, as identified using the Bonferroni Outlier Test in R, to observe the consistency of results. No extreme outliers or highly influential cases were identified. Also, no cubic relations were found in any regressions, and thus are not reported.

Regression Models

Two regression models were run, one on each event type narrated.

Negative Events. A significant curvilinear relation between automated coherence and hand-coded coherence was observed: $\Delta R2 = .079$, $\Delta F(1, 206) = 17.958$, $p < .001$. In total, the regression model on linear and non-linear automated coherence explained 9.1% in hand-coded coherence. Please see Table 3 for further details.

Positive Events. A significant curvilinear relation between automated coherence and hand-coded coherence was observed: $\Delta R2 = .065$, $\Delta F(1, 208) = 14.498$, $p < .001$. In total, the regression model on linear and non-linear automated coherence explained 6.5% in hand-coded coherence. Please see Table 4 for further details.

Discussion

The non-linear relationships between structural and semantic coherence support the notion that there are distinct indicators of coherence. Highly structurally coherent narratives

appear to need an optimal level of semantic coherence. On the one hand, too much semantic discrepancy from one sentence to the next is likely to result in a less structurally coherent narrative. The individual did not spend enough time developing a salient semantic space for the personal story. On the other hand, too much semantic overlap from one sentence to the next is also likely to result in a less structurally coherent narrative. The individual spent too much time developing a salient semantic space for the personal story. Too little or too much progression through semantic space are less likely to result in a well-structured narrative.

Study 1 helps establish a proof-of-concept measure for semantic coherence by observing a within-sample replication. In particular, there was a curvilinear relation between semantic coherence and structural coherence in both participants' positive and negative narratives. Because there were significant non-linear relationships, these measures appeared to be tapping different aspects of coherence. The next step is to follow up on objective one to determine the extent to which curvilinear automated coherence relates to structural coherence in another population, and then carry out objective two to determine if the automated measure can predict psychological health. If structural coherence is an indicator of ground truth and the semantic measure is another indicator of coherence, then the findings should be replicable in another sample.

Study 2

In study 2, the curvilinear relationship between hand-coded structural and automated semantic coherence was examined in another population. In addition, the extent to which automated coherence is related to important outcomes—including well-being, satisfaction with life, and stress levels—was also examined.

The mixed findings between structural coherence and psychological health in the literature present an opportunity to further delineate the conditions when the correlations are positive and negative. As discussed in the general introduction, individuals going through different developmental stages (e.g., young adolescents; McLean et al., 2010) or environmental factors (e.g., chronic stressors) demonstrate negative associations between narrative expression and psychological health. If the semantics of the narrative matter for psychological health, then they should help significantly explain health when the structure of the narrative is also in the regression models. Thus, study 2 allows for the replication of objective one—assessing the viability of an automated coherence measure in relation to hand-coded structural coherence—and the carrying out of objective two—assessing the automated coherence measure in relation to psychological health.

Method

Data were collected as part of a parent longitudinal data collection examining how people narrate highly emotional experiences over time from Amazon's Mechanic Turk (Mturk) via TurkPrime, which automated parts of the data collection process (Litman, Robinson, & Abberbock, 2016). Mturk is an increasingly popular and validated participant pool. Recent studies have found Mturk workers to be a more diverse participant pool and have the same data quality as more traditional participant pools, such as undergraduate students (Buhrmester, Kwang, & Gosling, 2011). In particular, the quality of narratives is comparable across undergraduate populations and Mturk participants (Grysman, 2015).

The present study utilizes the data from all 300 participants in the first time-point of data collection (m_{age} = 24.39, range from 18 to 29; 60% self-identified as women). The participants self-identified as predominately Caucasian (67%), followed by Black/African American (11%),

Hispanic/Latin-American (9%), Asian/Asian-American (6%), Multi-racial (5%), Native American/American Indian (1%), or another ethnicity (1%). At this time-point, participants were assessed on their personality and cognitive factors, in addition to writing narratives and being assessed on their levels of health. The following four time-points only prompted participants to write narratives and fill out the health questionnaires. Thus, the present study's aim to better specify relations between narrative coherence measures and well-being is best suited using time-point one data. Importantly, the participants in Study 2 were given almost identical negative and positive narrative prompts to the Study 1 participants.

Data Analysis Plan

The data analysis plan for study 2 is very similar to Study 1. The primary differences between Study 1 and 2 are that there are additional regressions with psychological health indices as outcomes, and that psychological health regressions are multiple regressions, not hierarchical multiple regressions, in order to determine if automated coherence is a unique predictor of psychological when hand-coded coherence was in the same regression models.

Narrative Coding

The Reese and colleagues (2011) coherence coding scheme was employed using the same training and reliability procedures as Study 1. Reliability was again excellent: theme (α =.93); context (α = .95); and chronology (α = .92). The same automated coherence tool was used again on the present study's negative and positive narratives.

Psychological Well-being Measures

The study relied on three indicators of well-being in order to tap theoretically different aspects of psychological health (Ryan & Deci, 2001).

Psychological well-being was assessed using the *Brief Personal Well-being Scale, short form* (Ryff, 1989), which comprises 18-items rated on a 6-point scale (1= *Strongly disagree* and 6 = *Strongly agree*). For example, "I have confidence in my opinions, even if they are contrary to the general consensus." Based on empirical recommendations to bolster reliability, the six subscales (i.e., Positive relations, Autonomy, Environmental mastery, Purpose in Life, Personal Growth) were summed together for one composite measure (Kafka & Kozma, 2002). Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent higher rated psychological well-being. Reliability on this scale was strong for this sample (α =.86).

Life Satisfaction was assessed using the *Satisfaction with Life Scale* (Diener, Emmons, Larsen, & Griffin, 1985), which comprises 5-items rated on a 7-point scale (1= *Strongly disagree* and 7 = *Strongly agree*). For example, "The conditions of my life are excellent." Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent greater satisfaction with life. Reliability on this scale was strong for this sample (α = .90).

Stress was assessed using the *Perceived Stress Scale* (Cohen, Kamarck, & Mermelstein, 1994), which comprises 10-items rated on a 5-point scale (0 = *Never* and 4 = *Very Often*). For example, "In the last month, how often have you been upset because of something that happened unexpectedly?" Negatively worded items were reverse coded, and then all items were summed together for a composite score. Thus, higher scores represent higher rated stress. Reliability on this scale was strong for this sample (α = .89).

Results

Descriptives. The most narrated topics for traumatic memories concerned Accidents/illnesses (37.33%) whereas the majority of the narrated positive memories concerned Interpersonal relations (50.00%). Please see Table 5 for more details on all narrated categories.

Preliminary Analyses

For descriptives and correlations on all narrative measures, please see Table 6 As expected, the health measures are highly intercorrelated with each other, ranging from .47 to .61 in effect size. There was a small significant relation between hand-coded coherence of negative events and automated coherence of negative events (r = .12, p = 0.042), but no significant relation between hand-coded and automated measures for positive events (r = .09, p = 0.123). Automated coherence from negative events was highly positively correlated with automated coherence from positive events (r = .86, p < .001), as was the relation between hand-coded measures for positive and negative events (r = .52, p < .001).

Regression diagnostics. All of the following regressions were checked for the assumptions of normality, homoscedasticity, collinearity, and nonlinearity, none of which were violated. Autocorrelations and outliers were also assessed. As a sensitivity check, regressions were run with and without outliers in the dataset, as identified using the Bonferroni Outlier Test in R, to observe the consistency of results. In these sensitivity analyses, the few outliers were not removed from final analyses because zero changes were observed in the findings. Again, no cubic relations were found in any regressions, and thus are not reported. Of note, because coherence from positive and negative events both in hand-coded and automated measures, were correlated the regressions needed to be performed separately for positive and negative event type to avoid issues of collinearity.

Objective 1: Relations between hand-coded and automated coherence

Two regression models were run, one on each event type.

Negative Event Narratives. A significant curvilinear relation between automated coherence and hand-coded coherence was observed: $\Delta R2 = .033$, $F(1, 274) = 9.603$, $p < .001$. In total, the regression model on linear and non-linear automated coherence explained 4.8% in hand-coded coherence. Please see Table 7 for further details.

Positive Events Narratives. A significant curvilinear relation between automated coherence and hand-coded coherence was observed: $\Delta R2 = .050$, $F(1, 278) = 14.818$, $p < .001$. In total, the regression model on linear and non-linear automated coherence explained 5.9% in hand-coded coherence. Please see Table 8 for further details.

Objective 2: Relations between psychological health and coherence measures

Six regression models were run in total, one on each event type for all three psychological measures – well-being, satisfaction with life, and stress.

Psychological health in negative events. Higher hand-coded coherence related to higher well-being levels ($\beta = 0.20$, $t = 3.299$, $p = .001$), but automated coherence did not relate to well-being. Similarly, for life satisfaction and stress levels, no coherence measures significantly predicted well-being scores, with standardized beta's ranging from -.05 to .07. Please see Table 9 for further details.

Psychological health in positive events. Both hand-coded coherence ($\beta = 0.16$, $t = 2.628$, $p = .009$), as well as curvilinear automated coherence predicted well-being levels ($\beta = -0.13$, $t = -2.057$, $p = .041$). However, similar to negative event narratives, no coherence measures significantly predicted life satisfaction and stress levels scores, with standardized beta's ranging from -.05 to .06. Please see Table 10 for further details.

Discussion

The results of study 2 replicated the results of study 1 in that there are multiple indicators of narrative coherence. Structurally coherent narratives need an optimal level of semantic coherence. Narrators with an optimum balance of semantic coherence tend to have a highly structured story. In other words, narrators that progress through their story at an optimum space are more likely to have well-structured stories. Too much or too little progression through semantic space are less likely to have a well-structured narrative.

Both hand-coded and automated coherence relate to well-being. These findings align with previous findings because coherence tends to most relate to levels of well-being, but not other indices of psychological health (see Adler et al., for review). People with higher senses of well-being have both more structural and semantic coherence to their personal stories for positive events.

General Discussion

The present studies explored hard-to-identify semantics of personal narratives, as well as provided theoretical and methodological specificity to the construct of coherence and its relationships to psychological health. In doing so, the viability of an automated semantic coherence measure in relation to hand-coded structural coherence and well-being was observed. The findings demonstrate that aspects of narrative coherence can be meaningfully captured in an automated manner. Importantly, the automated measure for semantic coherence was not designed to replace any hand-coded measures, but rather reflexively reveal the complexities of the construct. There appear to be multiple indicators of coherence that help further identify why some highly structured narratives might relate to lower well-being.

The studies found curvilinear relationships across two datasets, each displaying within-sample replication across positive and negative narratives. The consistent finding was that an

optimal level of semantic coherence related to higher structural coherence scores in personal narratives. In study 2, the semantic coherence measure was extended in scope to assess its predictive power for health indices—well-being, life satisfaction, and stress. Again, an optimal level of semantic coherence related to higher well-being, but not life satisfaction or stress. Altogether, there appears to be an optimal level of semantic coherence that is associated with higher structure in narratives, as well as higher well-being, which supports the semantic coherence hypothesis suggested by Bedi and colleagues, who observed that individuals with a diagnosis of schizophrenia had markedly lower semantic coherence than those without a clinical diagnosis.

These findings may provide some explanation of the mixed findings regarding the relationship between narrative coherence and well-being in non-clinical samples. For example, McLean and colleagues have observed that the typical health benefits from narrating personal stories are not displayed until individuals are near adulthood (McLean et al., 2010; McLean & Pratt, 2006). Although late adolescents display *higher* correlations between well-being and higher narrative sophistication (i.e. greater theme and context), young and middle adolescents display *lower* correlations between well-being and higher narrative sophistication (McLean & et al., 2010). McLean and colleagues contend that cognitive efforts after a sophisticated account of personal experience may lead to distress if adolescents do so before they have the cognitive and emotional skills to integrate the details of the events.

The present research offers another layer of interpretation for what comprises a sophisticated narrative account. Optimal semantic coherence might be a developmentally difficult kind of coherence to achieve. An adolescent's primary developmental project is forming a life identity (Erikson, 1968). Forming a life identity entails weaving together autobiographical

experiences to form an overarching life story that describes who one is, has been, and will go on to be as a unique self in the world (McAdams, 2008). At the same time, an adolescent's ability to develop a life story becomes increasingly sophisticated (Harter, 1998; Pasupathi & Wainryb, 2010). One's ability to create thematic coherence, in particular, is the last sub-component of structural coherence to fully develop (Habermas & de Silveira, 2008), enabling one to integrate causal-motivational themes to describe how and why events happened across a more temporally extended frame than earlier in development (see Fivush & Graci, 2017, for further arguments). Taken together, semantic forms of narrative coherence are later developmental achievements.

Thus, despite adolescents being able to construct higher structurally coherent narratives, young and middle adolescents might be more likely to have too high or too low of semantic coherence scores. These findings suggest that it is not just how individuals are narrating their stories, but also what content they are including in them and the semantic pace at which they are including them. Low automated coherence scores are moving the plot along too quickly or haphazardly, whereas high automated scores are moving the plot along too slowly or rigidly. The optimal semantic arc to one's semantic coherence might be a developmental achievement that relates with both higher structure and well-being.

In addition to providing a more nuanced understanding of narrative coherence, the sematic measure can be further engineered in a scalable, theory-driven manner in at least two ways. For example, the tool can be systematically changed to measure every other sentence in order to measure 2nd order coherence (i.e., measure sentence 1 to 3, 2 to 4, etc.), 3rd order coherence (i.e., measure sentence 1 to 4, 2 to 5, etc.), and so on. Such parameter changes can generate new hypotheses by examining how semantic coherence is altered by the window size of the measurement. For example, if people experiencing chronic stressors have a more difficult

time creating optimal semantic coherence, they should have even more volatile semantic coherence scores than those without chronic stressors, with an increasingly large window size. With a greater window size, the predictions would be that people experiencing chronic stressors with the lower scores on 1st order semantic coherence would have even lower scores on 3rd order semantic coherence, and people experiencing chronic stressors with higher scores on 1st order semantic coherence would look more like those without chronic stressors in the optimal semantic coherence range. The engineering decisions in this semantic coherence measure are not necessary bugs in the tool, but an opportunity for future hypotheses.

Many of the engineering decisions in constructing the semantic coherence measure can be turned into theoretically informative hypotheses. For example, if the manipulation checking tool was used to solely randomize the verbs in the narratives, and such randomization even further reduced the automated coherence score compared to randomizing all the words, then this selective verb randomization could support the notion that actions are critical to one's semantic coherence. The same process could be performed for other parts of language. All of these engineering decisions remind us that the idea that this automated tool is a reflexive one. The extent to which indicators of coherence can be broken down and rebuilt highlights the ability to develop a more nuanced understanding of the underlying construct of coherence.

There are clearly several limitations to the present studies, including the corpus used to create the semantic space and its generalizability to other populations. The corpus used might not be the most indicative of the way in which people tell their own stories, and being mindful of the source, or style of writing, for the corpus would be theoretically informative to note. Moreover, the semantic space for each individual could very well be different. For example, children and adolescents likely have a different semantic space than adults–both in size and the relationships

between words. In addition, there are other automated tools, primarily from the education literature, that assess aspects of coherence (e.g., reading fluency; Graesser, McNammara, & Kulikowish, 2011). An important next step for the semantic coherence tool would be to investigate this measure with related tools from other disciplines in order to further understand the underlying components to the construct of narrative coherence. These tools provide reflexive opportunities to ask questions about how people narrate the stories of their lives and how we measure them.

Further steps can be taken to capture the semantic coherence of personal narratives. This study demonstrates a proof-of-concept measure that we can use to begin approximating indicators of coherence, and do so in theory-driven ways. There appears to be an optimal level of semantic coherence that relates with higher structurally coherent narratives and levels of well-being. We can capitalize on the hard-to-identify underlying statistics of language usage to better understand how people share their personal stories.

References

Adler, J. M., Chin, E. D., Kolisetty, A. P., & Oltmanns, T. F. (2012). The distinguishing characteristics of narrative identity in adults with features of borderline personality disorder: an empirical investigation. *Journal of personality disorders, 26*(4), 498-512.

Baerger, D. R., & Berger, F. R., Gupta, W. B., & Berger, R. M. (1990). *Air Force officer qualifying test (AFOQT) Form P: Test manual*. PSYCHOMETRICS INC SHERMAN OAKS CA.

Bedi, G., Carrillo, F., Cecchi, G. A., Slezak, D. F., Sigman, M., Mota, N. B., ... & Corcoran, C. M. (2015). Automated analysis of free speech predicts psychosis onset in high-risk youths. *npj Schizophrenia, 1*, 15030.

Buck, B., & Penn, D. L. (2015). Lexical characteristics of emotional narratives in schizophrenia: relationships with symptoms, functioning, and social cognition. *The Journal of nervous and mental disease, 203*(9), 702-708.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives on psychological science, 6*, 3-5.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*.

Costa, P. T. Jr., & McCrae, R. R. (1992). *Revised NEO Personality Inventory* (NEO-PI-R) *and NEO Five-Factor Inventory* (NEO-FFI) *professional manual*. Odessa, FL: Psychological Assessment Resources.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of personality assessment*, *49*(1), 71-75.

Erikson, E. H. (1968). Life cycle. *International encyclopedia of the social sciences*, *9*, 286-292.

Fivush, R. (2011). The development of autobiographical memory. *Annu Rev Psychol*, *62*, 559-582.

Fivush, R., & Graci, M.E. (2017) Autobiographical Memory. In: Wixted, J.T. (ed.), Cognitive Psychology of Memory, Vol. 2 of Learning and Memory: A Comprehensive Reference, 2nd edition, Byrne, J.H. (ed.). pp. 119–135. Oxford: Academic Press.

Friedman, H. S., & Kern, M. L. (2014). Personality, well-being, and health. *Annual review of psychology*, *65*, 719-742.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why?. *Current Directions in Psychological Science*, *13*, 1-4.

Graci, M. E., Watts, A. L., & Fivush, R. (2018). Examining the factor structure of narrative meaning-making for stressful events and relations with psychological distress. *Memory*, 1-13.

Graesser, A. C., McNamara, D. S., & Kulikowich, J. M. (2011). Coh-Metrix: Providing multilevel analyses of text characteristics. *Educational researcher*, *40*, 223-234.

Grysman, A. (2015). Collecting narrative data on Amazon's Mechanical Turk. *Applied Cognitive Psychology*, *29*(4), 573-583.

Habermas, T., & de Silveira, C. (2008). The development of global coherence in life narratives across adolescence: Temporal, causal, and thematic aspects. *Developmental psychology*, *44*(3), 707-721.

Harter, S. (1998). The development of self-representations. In N. Eisenberg & W. Damon (Eds.), Handbook of child psychology, 5th edition (Vol. 3, pp. 553–617). New York, NY: John Wiley and Sons.

Kafka, G. J., & Kozma, A. (2002). The construct validity of Ryff's scales of psychological well-being (SPWB) and their relationship to measures of subjective well-being. *Social Indicators Research*, *57*(2), 171-190.

Lilgendahl, J. P., & McAdams, D. P. (2011). Constructing stories of self-growth: How individual differences in patterns of autobiographical reasoning relate to well-being in midlife. *Journal of Personality, 79,* 391-428.

Litman, L., Robinson, J., & Abberbock, T. (2016). TurkPrime. com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods,*1-10.

Lyubomirsky, S., Sousa, L., & Dickerhoof, R. (2006). The costs and benefits of writing, talking, and thinking about life's triumphs and defeats. *Journal of Personality and Social Psychology, 90,* 692-708.

McAdams, D. P. (2008). Personal narratives and the life story. *Handbook of personality: Theory and research, 3,* 242-262.

McAdams, D. P., & McLean, K. C. (2013). Narrative identity. *Current directions in psychological science*, *22*(3), 233-238.

McLean, K. C., Breen, A. V., & Fournier, M. A. (2010). Constructing the Self in Early, Middle, and Late Adolescent Boys: Narrative Identity, Individuation, and Well-Being. *Journal of Research on Adolescence*, *20,* 166-187.

McLean, K. C., & Pratt, M. W. (2006). Life's little (and big) lessons: identity statuses and meaning-making in the turning point narratives of emerging adults. *Developmental psychology*, *42*, 714-722.

Mikolov, T. Sutskever, I. Chen, K. Corrado, G. & Dean, J. (2013). Distributed representations of words and phrases and their compositionality. *Advances in neural information processing systems, 26,* 1081-1888.

Mikolov, T., Yih, W. T., & Zweig, G. (2013). Linguistic regularities in continuous space word representations. In *Proceedings of the 2013 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies* (pp. 746-751).

Oppenheimer, D. M., Meyvis, T., & Davidenko, N. (2009). Instructional manipulation checks: Detecting satisficing to increase statistical power. *Journal of Experimental Social Psychology, 45,* 867-872.

Pasupathi, M., & Wainryb, C. (2010). On telling the whole story: Facts and interpretations in autobiographical memory narratives from childhood through midadolescence. *Developmental Psychology*, *4*), 735-746.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science, 8*(3), 162-166.

Pennebaker, J. W., & Chung, C. (2011). Expressive writing and its links to mental and physical health. *Oxford handbook of health psychology*, 417-437.

Reese, E., Haden, C. A., Baker-Ward, L., Bauer, P., Fivush, R., & Ornstein, P. A. (2011). Coherence of personal narratives across the lifespan: A multidimensional model and coding method. *Journal of Cognition and Development, 12,* 424-462.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual review of psychology*, *52*, 141-166.

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of personality and social psychology*, *57*(6), 1069-1081.

Sales, J. M., Merrill, N. A., & Fivush, R. (2013). Does making meaning make it better? Narrative meaning making and well-being in at-risk African-American adolescent females. *Memory, 21*, 97-110.

Takano, K., Ueno, M., Moriya, J., Mori, M., Nishiguchi, Y., & Raes, F. (2017). Unraveling the linguistic nature of specific autobiographical memories using a computerized classification algorithm. *Behavior research methods*, *49*, 835-852.

Waters, T. E., Bohanek, J. G., Marin, K., & Fivush, R. (2013). Null's the word: A comparison of memory quality for intensely negative and positive events. *Memory, 21*, 633-645.

Waters, T. E., & Fivush, R. (2015). Relations between narrative coherence, identity, and psychological well-being in emerging adulthood. *Journal of personality*, *83*, 441-451.

Waters, T. E., Shallcross, J. F., & Fivush, R. (2013). The many facets of meaning making: Comparing multiple measures of meaning making and their relations to psychological distress. *Memory*, *21*, 111-124.

Table 1

Narrative Categories for Study 1

Event Categories	Event Type	
	Negative	Positive
Accidents/illnesses	55%	2%
Achievements/failures	11%	53%
Relationships	10%	13%
Family events	10%	19%
Travel	5%	13%
Sexual violence/abuse	6%	0%
Disaster/terrorism	2%	0%

Table 2

Study 1 Means, standard deviations, and correlations for all 224 participants

Variable	*M*	*SD*	1	2	3
1. Negative Event Hand-coded Coherence	6.91	1.81			
2. Positive Event Hand-coded Coherence	6.34	2.08	.34** [.21, .45]		
3. Negative Event Automated Coherence	0.70	0.07	.11 [-.02, .25]	.16* [.02, .29]	
4. Positive Event Automated Coherence	0.72	0.06	.11 [-.03, .24]	-.02 [-.15, .12]	.26** [.12, .39]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

Table 3

Study 1 Regression Results Using Hand-coded Coherence from Negative Events as the Outcome

Predictor	*b*	*b* 95% CI [LL, UL]	*beta*	*beta* 95% CI [LL, UL]	Fit	Difference
(Intercept)	6.93**	[6.69, 7.18]				
Automated Coherence	2.89	[-0.70, 6.47]	0.11	[-0.03, 0.25]		
					R^2=.012	
(Intercept)	7.15**	[6.89, 7.40]				
Automated Coherence	1.06	[-2.48, 4.61]	0.04	[-0.09, 0.18]		
Automated Coherence^2	-53.44**	[-78.31, -28.58]	-0.29**	[-0.42, -0.16]		
					R^2 = .091**	ΔR^2 = .079** 95% CI [.01, .15]

Note. b represents unstandardized regression weights. *beta* indicates the standardized regression weights. * indicates $p < .05$. ** indicates $p < .01$.

Table 4

Study 1 Regression Results Using Hand-coded Coherence from Positive Events as the Outcome.

Predictor	*b*	*b* 95% CI [LL, UL]	*beta*	*beta* 95% CI [LL, UL]	Fit	Difference
(Intercept)	6.36**	[6.09, 6.63]				
Automated Coherence	-0.49	[-4.94, 3.96]	-0.02	[-0.15, 0.12]		
					R^2 = .000	
(Intercept)	6.70**	[6.39, 7.02]				
Automated Coherence	-2.91	[-7.40, 1.58]	-0.09	[-0.23, 0.05]		
Automated Coherence^2	-96.28**	[-146.12, -46.43]	-0.27	[-0.40, -0.13]		
					R^2 = .065**	ΔR^2 = .065** 95% CI [.00, .13]

Note. b represents unstandardized regression weights. *beta* indicates the standardized regression weights. * indicates $p < .05$. ** indicates $p < .01$.

Table 5

Narrative Categories for Study 2

Event Categories	Event Type	
	Negative	Positive
Interpersonal relationships	37.33%	50%
Achievements/failures	3.33%	29.67%
Death/loss	21.33%	0.00%
Serious illness or injury	17.33%	0.00%
Sexual violence/abuse	12.33%	0%
Self-improvement	0.00%	7.33%
Other	8.33%	13%

Table 6

Study 2 Means, standard deviations, and correlations for all 300 participants

Variable	*M*	*SD*	1	2	3	4	5	6
1. Well-being	76.36	11.66						
2. Satisfaction with Life	22.20	7.02	.61**					
			[.53, .67]					
3. Stress	17.43	7.97	-.57**	-.60**				
			[-.64, -.48]	[-.67, -.53]				
4. Negative Event Hand-coded Coherence	6.72	1.90	.23**	.07	-.03			
			[.12, .34]	[-.05, .18]	[-.14, .09]			
5. Positive Event Hand-coded Coherence	6.71	2.03	.21**	-.01	-.01	.52**		
			[.10, .32]	[-.12, .11]	[-.12, .11]	[.43, .60]		
6. Negative Event Automated Coherence	0.73	0.07	.12*	.05	-.05	.12*	.14*	
			[.00, .24]	[-.07, .16]	[-.17, .07]	[.00, .24]	[.03, .26]	
7. Positive Event Automated Coherence	0.74	0.07	.07	.07	-.06	.09	.09	.86**
			[-.05, .19]	[-.04, .19]	[-.17, .06]	[-.03, .21]	[-.03, .21]	[.83, .89]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

Table 7

Study 2 Regression Results Using Hand-coded Coherence from Negative Events as the Outcome.

Predictor	*b*	*b* 95% CI [LL, UL]	*beta*	*beta* 95% CI [LL, UL]	Fit	Difference
(Intercept)	6.71**	[6.49, 6.94]				
Automated Coherence	3.42*	[0.12, 6.72]	0.12	[0.00, 0.24]		
					R^2 = .015*	
(Intercept)	6.89**	[6.64, 7.13]				
Automated Coherence	1.45	[-2.03, 4.93]	0.05	[-0.07, 0.18]		
Automated Coherence^2	-38.31**	[-62.64, -13.97]	-0.20	[-0.32, -0.07]		
					R^2 = .048**	ΔR^2 = .033** 95% CI [.00, .07]

Note. b represents unstandardized regression weights. *beta* indicates the standardized regression weights. * indicates $p < .05$. ** indicates $p < .01$.

Table 8

Study 2 Regression Results Using Hand-coded Coherence from Positive Events as the Outcome.

Predictor	*b*	*b* 95% CI [LL, UL]	*beta*	*beta* 95% CI [LL, UL]	Fit	Difference
(Intercept)	6.76**	[6.52, 6.99]				
Automated Coherence	2.47	[-0.68, 5.61]	0.09	[-0.03, 0.21]		
					R^2 = .008	
(Intercept)	7.04**	[6.77, 7.30]				
Automated Coherence	0.59	[-2.62, 3.81]	0.02	[-0.10, 0.14]		
Automated Coherence^2	-50.28**	[-75.99, -24.57]	-0.23**	[-0.35, -0.11]		
					R^2 = .059**	ΔR^2 = .050** 95% CI [.00, .10]

Note. b represents unstandardized regression weights. *beta* indicates the standardized regression weights. * indicates $p < .05$. ** indicates $p < .01$.

Table 9

Multiple Regression between psychological health on narrative coherence predictors of negative events

	Health Indices		
	Well-being	Life Satisfaction	Stress
Hand-coded Coherence	0.20*	0.07	-0.01
Automated Coherence	0.06	0.05	-0.05
Automated Coherence^2	-0.08	0.04	0.00
R^2	.064**	.007	.003

Note: Standardized Beta's are reported. Statistical significance is denoted as follows: *p < .05; **p < .01.

Table 10

Multiple Regression between psychological health on narrative coherence predictors of positive events

	Health Indices		
	Well-being	Life Satisfaction	Stress (9)
Hand-coded Coherence	0.16*	-0.03	0.02
Automated Coherence	0.02	0.06	-0.05
Automated Coherence^2	-0.13*	-0.04	0.02
R^2	.055**	.007	.004

Note: Standardized beta's are reported. Statistical significance is denoted as follows: *p < .05; **p < .01.

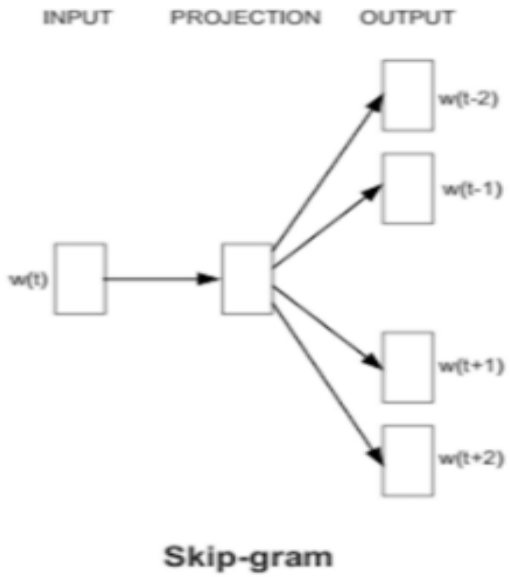

Figure 1. Word2Vec Skipgram model. The model takes in words as input from a large corpus, and then tries to predict the surround words in the window.

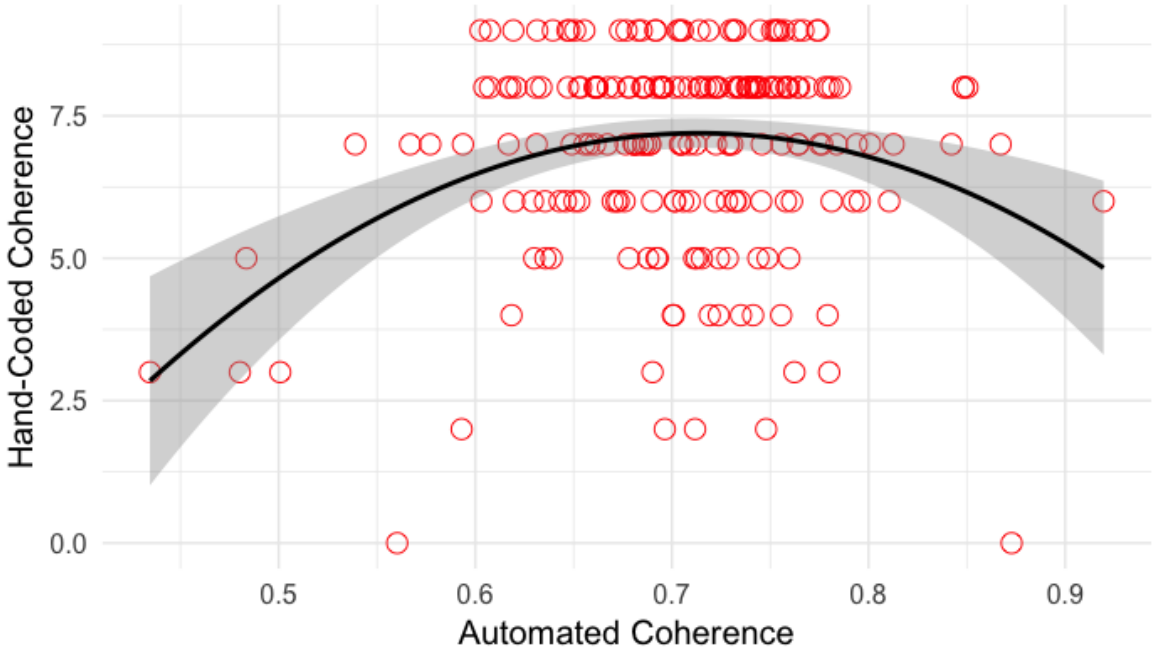

Figure 2. Study 1 relations between hand-coded and automated coherence in negative events.

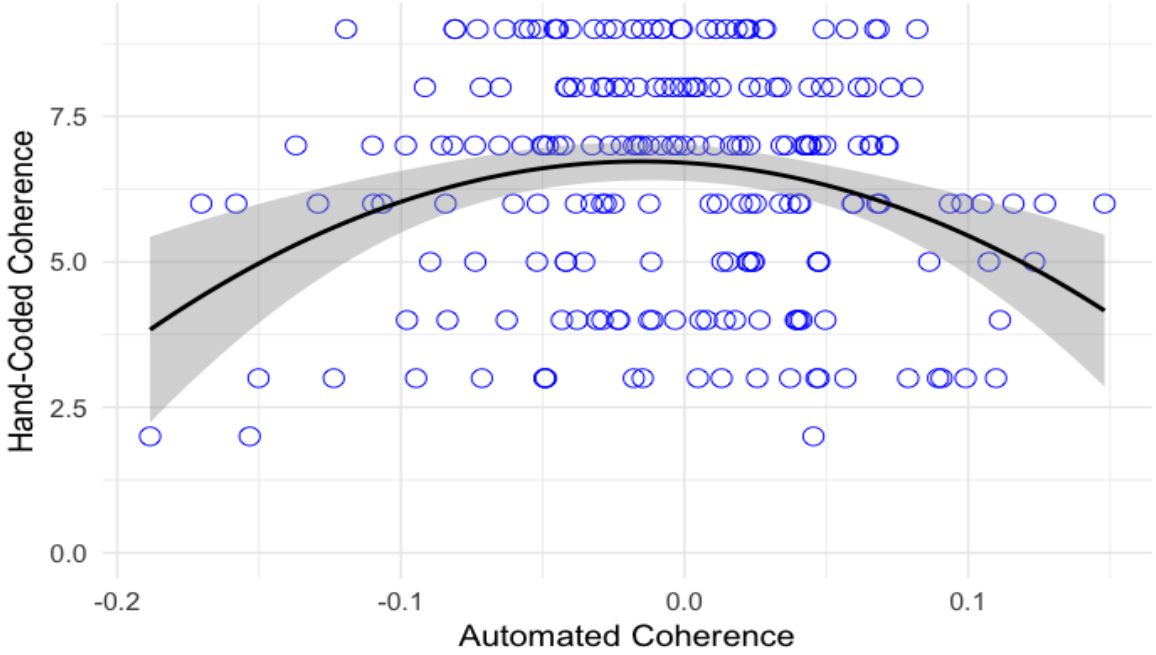

Figure 3. Study 1 Relations between hand-coded and automated coherence in positive events.

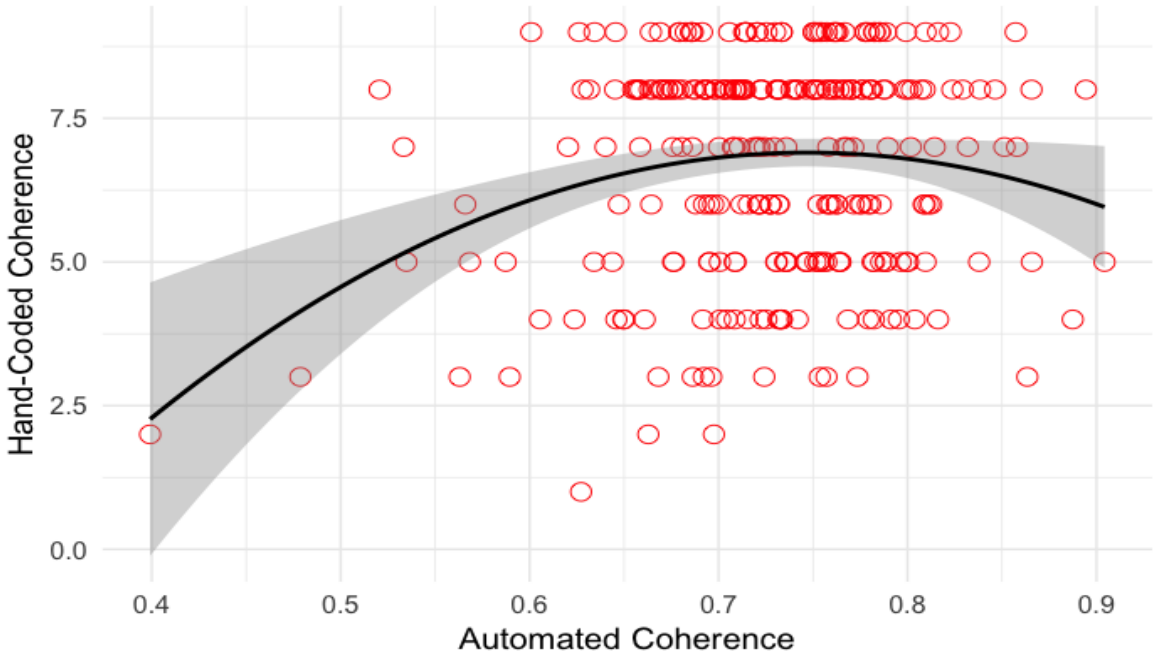

Figure 4. Study 2 relations between hand-coded and automated coherence in negative events.

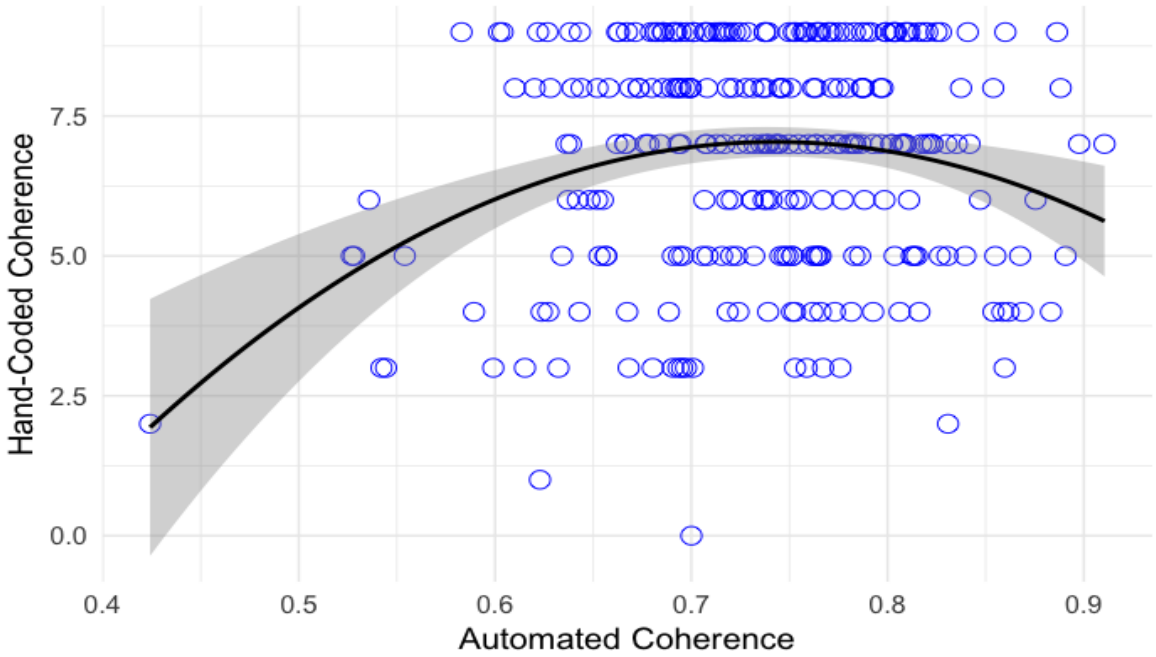

Figure 5. Study 2 Relations between hand-coded and automated coherence in positive events.

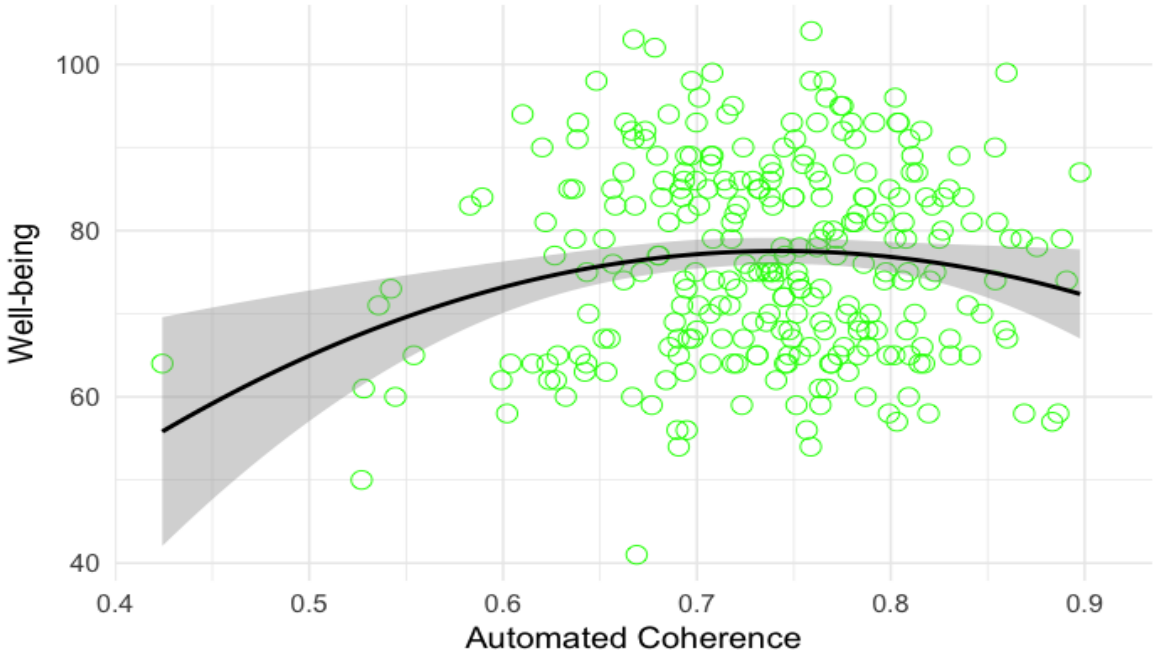

Figure 6. Study 2 Relations between well-being and automated coherence in positive events.

Appendix A
Verbatim Hand-coded Scoring Narrative Examples.

Narrative Scoring	Example
Coherence	
Low Score	One of the most negative experiences of my life was when my parents announced they were getting divorced. It put a pit in my stomach. I couldn't breath and it felt like I was in shell shock. It was so out of the blue that I had no idea how to process it. It felt like someone had died. I felt like crying and running away. I was just in so much shock that I just sat there, with no idea what to do or say.
High Score	The most traumatic experience of my life was catching my alcoholic father sneak a drink from the kitchen. My father had been in rehab several times in the last few years, and my mother and I finally had hope that he was getting better. Then, over a period of a few months, he began acting weird again, and he and my mother would fight, but no one would tell me why although I knew. At the dinner table, his eyes would roll in the back of his head because he was mixing alcohol with pain killers (but completely denying that he was drinking). One day, my boyfriend was over, and I heard my dad open the cupboard, and I was very suspicious, so I opened my door a crack and saw him taking a bottle of cognac into his room. My mom doesn't keep any alcohol in the house, but she cooks with cognac, and that was his drink of choice. I immediately confronted my dad about it, sent my boyfriend home, and listened to my dad begging and literally crying to me to not tell my mom. This was so difficult seeing my own father in such a miserable, desperate shape. It was also difficult that he was making me keep it from my mom because her and I her very close. I made him promise that he would go to rehab and after 4 hours of him crying and making me feel so hopeless and emptying out his problems with life, employment, his marriage and the family on me, I told him to leave my room. He went to rehab shortly after, and I told my mom what had happened after he went.

Appendix B
Verbatim Automated Scoring Narrative Examples

Scoring	Narrative
Low Score Example 1	When I was a senior in high school my mother's husband (my stepfather) became abusive. He was likex a volcano. We would go through stretches of calm and he would randomly erupt. I was so scared for her sake and my own. She kept coming back to him and I didn't understand why
Low Score Example 2	I have unfortunately experienced MANY traumatic events, all over time things that still occur or have affects today. Its hard to point to a specific event, but I can try to use an emotional moment that reveals a lot: My parents got divorced, or told my younger sister and I they were the beginning of the summer I was 12 (after already being "separated" for years) my father living in a separate bedroom for as long as I can remember. Can not remember well Unsure where my Sis and I were? That same day cops were called on my father as my mother claimed he beat her, he claimed she beat up herself. To this day I don't know the truth. My dad only had to spend hours in a holding cell. My dad moved out. I went to sleep away. You are allowed 2 phone calls per 8 weeks at my camp. I remember my call to my father. He cried. It was the first time I'd heard a man cry and it was my dad? It all seemed so wrong. He was supposed to be the big kid, protect me, be brave and strong and he was falling apart. He was scared, I could hear it in his voice. Scared if he was going to see us (his biggest fear and main reason for not leaving earlier) He was homeless, sleeping at his tennis club he ran. I just remember thinking if daddy can't tell me it's going to be ok than who can? At that moment, the answer was no one.
High Score Example 1	The most traumatic experience of my life was the death of a family friend. She wasn't close to me; in fact, I'd only talked to her a few times, but I think I was so upset over her death because it was so sudden and unfair. She was only 56, and she was putting some hitching posts or something for her horses back in the truck when everything fell on her, giving her intense internal trauma. While I wasn't there for her actual death, I do remember her funeral. Even the priest seemed a little frustrated with God to have her taken away for no good reason. Even though I was incredibly sad and cried a lot harder at my grandfather's funeral, I was more traumatized by hers because she seemed likex she had so much life ahead of her. It made me realize that any of us could die at any second; I was jumpy and thought about death a lot for a few weeks after. Another traumatizing aspect of the situation was how upset my dad became. He was easily agitated and as confused about what happened as I was, which scared me even more because my parents are "supposed" to have the answers for me - I felt truly lost
High Score Example 2	I haven't had many traumatic experiences in my life, but one that struck me really hard was in the summer before going to college thousand and five , I got a bad hair cut right before going to orientation and my self esteem at the time was very fragile and I was looking forward to looking my best, I almost took it for granted that I would, and when the barber butchered my hair, my self esteem unraveled and I was in tears. I thought no one would think I was good looking, no girls would want to talk to me, that was the levelof my self esteem problems, but thankfully, it did not last too long.

General Discussion

Across three studies, I addressed the following objectives: 1) to examine the *incremental validity* of narratives; 2) to examine the possible *longitudinal effect* of narrative on health; and 3) to implement *machine learning* approaches for specifying the extent to which narrative processing relates to well-being. The main findings were threefold: 1) narrative expressions matter over and above verbal ability and personality variables to understand health indices; 2) narrative expressions consistently predict health over five points in time, over and above verbal ability and personality variables; and 3) implementing a machine learning algorithm helps derive a new indicator of narrative coherence that provides new insights into the construct of coherence.

The overarching theme in my dissertation is the importance of measurement in narrative. A common critique in the narrative field is that better storytellers are merely the participants narrating the healthier stories. Thus, Article one examined narrative in relation to health while controlling for a measure of verbal ability, along with other important covariates. Another common critique in the field refers to the reliance on one time-point to collect both narrative and health measures; or, if more than one time-point is collected, only narrative or health are assessed at multiple points. Thus, to address this critique, Article two assessed narrative and health across five time-points. Yet additional critique surrounds the underlying conceptualizations of narrative coherence. Thus, Article three implemented a new way to measure coherence—semantic coherence—to further drive theory on the underlying indicators of the construct. Personal narratives contain multitudes, and these three articles help further specify narrative measurement and how each uniquely relates to health.

Narrative is a unique tool to understanding one's subjective experience. Cognitive researchers focus on narratives as vehicles for thoughts, feelings, goals, beliefs, reasoning

processing, and the like to come together in a coherent storyline (Bruner, 1991), whereas personality researchers focus on narratives as a layer of personality directly involved in shaping the subjective experience of situations (McAdams, 2008). When the present research controlled for the directly relevant factors from both fields, namely verbal ability and personality, narrative remained its own unique level of analysis that contributed to explaining lived experience, insofar as explaining health indices. How people tell their personal stories matters over and above what kinds of people are telling them when attempting to understand their levels of psychological health.

Autobiographical memory is thought to serve many functions, including emotion-regulation. The three general functions are: 1) forming a self-identity; 2) directing future behaviors; and 3) emotion regulation (Bluck, 2003; Fivush, 2011). If narrative serves an emotion-regulation function, then it should consistently predict health over time. The present research focused on the robustness of the relationship between narrative and health by assessing the relationship between narrative coherence and narrative growth to health indices across five time-points. The robustness of the relationship between narrative and health held across five time-points and covariation with other factors, further supporting the notion that narrative serves an emotion-regulation function for the self.

Further, the words with which people choose to narrate the stories of their lives appear to have associated statistical properties. Whereas many would easily accept we care about the things we choose to talk about, a more extreme argument is that there are underlying statistics to such word usage. The present research utilized a machine learning algorithm, Word2vec (W2V), which is a neural network to capture the semantics of language (Mikolov, Sutskever, Chen, Corrado, & Dean, 2013). In particular, W2V followed the *distributed semantics* premise, in

which words that tend to occur in similar places also tend to have similar meanings (Firth, 1957). Implementing this algorithm appeared to meaningfully capture the semantic coherence of personal stories. The semantic coherence measure observed a consistent relationship to hand-coded structural coherence four times across two independent samples. Implementing such methods offers an exciting path forward for narrative psychology, because tools, like the one created in the dissertation, offer ways to systematically study hard-to-observe narrative patterns.

Overarching conclusions and Limitations

As detailed in each article discussion, the articles were important for the incremental, lasting, and nuanced effects narrative have on health. Article one addressed the incremental effects. Article two addressed the lasting effects. Article three addressed the nuanced effects.

Article one addressed the widely held assumption that people with superior language ability generally make better narrators. Only one study has actually examined this and found that narrative expression is uniquely related to health when accounting for verbal SAT scores and educational attainment (Lilgendahl, Helson, & John, 2013). Findings from Article one replicate and expand this finding by using a more direct measure of verbal ability that again find that narrative expressions predict health indices when controlling for verbal ability. Though there are certainly more important cognitive factors to rule out, such as working memory (Klein & Boals, 2000), this study addresses an important gap in the literature. Individuals with more advanced verbal skills are not automatically better storytellers with greater levels of health. In addition to personality and cognitive skill sets, *how* personal stories are retold remain crucial.

Article two helps further elucidate how personal narratives provide subjective accounts to the objective realities of events (Bruner, 1991). The process of storying experience gives rise to both meaning and purpose in one's life (McAdams, 2008). Thus, individuals are continually

tasked with creating narratives for how events happened and continue to impact the self for future occurrences. Importantly, narrators' retellings of their past experiences are not solely concentrated on accurately recollecting their experiences (Gauld & Stephenson, 1967). There are many functional reasons why narrators retell their personal stories beyond conveying the facts of their experiences (Fivush, 2011). Personal narration might serve as a protective lens from which one creates healthy subjective accounts of experiences. Moreover, there appears to be an importance difference between positive and negative event narratives for healthy accounts of experiences. Negative event narrations might have more to do with resolving disruptive experiences to regulate emotions, whereas positive event narrations might be more critical to maintaining a basic level of well-being. Though these studies are not causal in nature and do not speak to narratives facilitating health, that personal narrations robustly relate to health further demonstrates the emotion-regulation function of narrative.

Article three offers another layer of interpretation for what comprises a sophisticated narrative account. Optimal semantic coherence might be a developmentally difficult kind of coherence to achieve. An adolescent's primary developmental project is forming a life identity (Erikson, 1960). Forming a life identity entails weaving together autobiographical experiences to form an overarching life story that describes who one is, has been, and will go on to be as a unique self in the world (McAdams, 2008). At the same time, an adolescent's ability to develop a life story becomes increasingly sophisticated (Harter, 1998; Pasupathi & Wainryb, 2010). One's ability to create thematic coherence, in particular, is the last sub-component of structural coherence to fully develop (Habermas & de Silveira, 2008), enabling one to integrate causal-motivational themes to describe how and why events happened across a more temporally extended frame than earlier in development (see Fivush & Graci, 2017, for further arguments).

Taken together, semantic forms of narrative coherence are later developmental achievements. Thus, despite adolescents being able to construct higher structurally coherent narratives, young and middle adolescents might be more likely to have too high or too low semantic coherence scores. These findings suggest that it is not just how individuals are narrating their stories, but also what content they are including in them and the semantic pace at which they are including them. Low automated coherence scores mean the plot is moving along too quickly or haphazardly, while high automated scores mean the plot is moving along too slowly or rigidly. The optimal semantic arc to one's semantic coherence might be a developmental achievement that relates to both higher structure and well-being. There is much more to be improved upon for this tool, including its generalizability to other populations (e.g. clinical populations) and further investigating the efficacy of the corpus used to create the semantic space for the coherence measure alongside other corpora. Nevertheless, we appear to be able to capitalize on the hard-to-identify underlying statistics of language usage to better understand how people share their personal stories.

Analytic decisions

In the process of conducting this research, I had to make many difficult decisions about measures and analyses. Here I discuss how these decisions may have impacted on my findings, and possible ways that future research might address these limitations.

Self Reports. All data collected was through self-reporting, which has several disadvantages. In particular, participants might withhold more personal information or present the information in a biased manner, such as presenting themselves in a more favorable light. Perhaps the largest caution to self-reporting is that participants can be biased in responding to items based on how they feel in the moment of self-reporting. For example, if participants feel

more lethargic at the moment of filling out the questionnaires, they might be less engaged, less forthcoming, less truthful, or the like. Such a worry was incorporated into the analysis plan for the second study, which assessed the longitudinal relations between narrative and health. If participants were feeling lesser-than in their self-reporting, the primary empirical question was still if their self-reporting of personal stories was indicative of their health *across multiple points* in time. Thus, whereas reports might be biased at one point in time, these analyses assessed the consistent effects across multiple points in time, and revealed that how individuals narrated their personal stories across time was indicative of their health. Nevertheless, a more well-rounded profile to individuals', which included both self-reporting and behavioral observations, would make for stronger arguments in assessing the mechanistic effects narrating personal stories has on how people think, feel, *and do.*

Verbal Ability. Verbal ability is a complex measure to collect, which is why it is often measured in a research lab. Two factors went into my decision. The first decision was theoretical—I sought to identify a verbal ability measure that taps fluid intelligence (Unsworth, 2010; Unsworth & Spiller, 2010), rather than crystallized intelligence, since there are many relationships between fluid intelligence and health (Gottfredson & Deary, 2004). Thus, it was important to obtain a measure that tapped one's verbal ability in a way that also measured their ability to think and reason adaptively with language. The second reason was more practical—many IQ measures are conducted in research labs in order to get a more widely-used measure of verbal ability. I could not have participants come into the lab, so I could not administer most of the other measures of verbal ability or fluid intelligence, but the measure used in the present research is still a valid and reliable measure, as found in other studies (Kane et al., 2004;

Unsworth; Unsworth & Spiller, 2010). Still, future research should certainly examine these relationships using a wider variety of measures of verbal IQ and fluidity.

Time Spent Writing as Covariate. The present studies opted for a stricter covariate than word count to rule out involvement in the writing process when assessing the relationships between narrative and health. In particular, even though similar kinds of data integrity issues are also found in campus and community samples, several studies demonstrate that Mturk participants can engage in behaviors that pose issues of data integrity (Necka, Cacioppo, Norman, Cacioppo, 2016; Peer, Vosgerau, & Acquisti, 2014). Thus, a crucial factor to rule out is time spent writing the narratives because it is also a measure of participant engagement. For example, participants, in theory, could have copy and pasted stories from the internet or their stories from previous sessions. In both cases, time spent writing the narrative would be shorter, accurately capturing their level of engagement, while the number of words would be speciously high. By controlling for time spent on writing narratives, the studies were able to simultaneously measure two things: how long participants wrote for, which is related to word count, and how engaged they were in the writing process.

New York Times Dictionary. Using the New York Times as the dataset to create the semantic space in Article two was an engineering decision. For example, there are other huge corpora out there to create the vast semantic space of the English language, such as *Wikipedia*. However, Wikipedia is even farther removed from natural personal storytelling styles, given its primary discourse of presenting overviews of information, rather than conveying stories. Perhaps a better dataset would be pulling comments from an internet community like *Reddit*. However, this putative corpus would still be less than ideal because it would still face generalization issues to more natural language styles, as much of the words collected on the website would be more

comments or reactions to stories, rather than stories themselves. Perhaps the most ideal corpus would be the *Storycorps* website because it entails people sharing a multitude of personal stories in organic ways. However, these personal stories are illegal to scrape. Thus, there are likely pros and cons to every corpus for creating a semantic space. Still, the selection of other dictionaries is more than just an optimization process, in which one simply tries to increase effect sizes of predictions, because it is theoretically informative to discern what kind of automated semantic spaces are most similar to those people organically use in their day-to-day lives.

Participant pool. The dissertation data collection further supports that collecting data from Amazon's Mechanical Turk (Mturk) platform is a viable path for empirical research. Recent studies have found Mturk workers to be a more diverse participant pool and have the same data quality as more traditional participant pools, such as undergraduate students (Buhrmester, Kwang, & Gosling, 2011). In particular, the quality of narratives is comparable across undergraduate populations and Mturk participants (Grysman, 2015). In the sample for the current research, the participants passed attention-checking questions, wrote for over eight minutes for each narrative, and kept coming back to write more about themselves. Retention for the entire study was 62 percent overall and strong across all waves of data collection (retention rates are as follows: Time-2: 81%; Time 3: 91%; Time 4: 89%; Time 5: 94%). Moreover, the majority of the community internet sample made under $37,650 and came from a wide range of educational backgrounds. The present studies were able to draw upon a diverse and engaged pool of participants.

Implications and Future Directions

An integral way to gain insights into people, their identities, and psychological states are through their narratives (Bruner, 1991). Knowing others entails more than adequately

understanding their current thoughts and feelings in order to explain their behaviors (Hutto, 2007). More specifically, knowing others also entails understanding that individuals are influenced by past behaviors and history, current circumstances and commitments, goals, and future projects (Fivush & Nelson, 2006; Lagattuta & Wellman, 2001) because these factors also guide how individuals know and remember themselves. Thus, in the empirical effort to understand who people are and their psychological states, knowing their personal stories are crucial areas of investigation.

How people narrate the specific events of their lives remains an important level of analysis to better understand lived experience. On a theoretical level, personal narratives of specific events are building blocks for an overarching life story and provide insight into individuals' autobiographical reasoning, goals, and motivations. These processes elucidate how and when narratives relate to well-being because they more clearly map narrative as a product of autobiographical memory (Conway & Pleydell-Pierce, 2000), in addition to a level of personality (McAdams, 2008). On a more practical level, event-level narratives are the most commonly used form of measurement in narrative study, in part because no one has difficulty completing such a task. The present research asked 300 people from around the United States to write about their personal experiences multiple times. Every participant had a story to tell, and kept coming back to tell more, as evidenced by the retention rate being approximately 90 percent from each week to the next. Such a high retention rate for a five time-point study further underscores the notion that human beings are storytelling creatures who are very capable and willing to share their own stories.

Still, there are many levels of personal narration. The multiple levels include life story narratives, general or repeated event narratives, and specific event narratives. The life story

creates a sense of unity, purpose, and meaning in one's life by reconstructing the past and connecting it to an imagined future (McAdams, 2008; McAdams & Pals, 2006). General events are narratives of recurring events from daily life. For example, going on an annual family vacation or one's commute to work may be considered general events. Specific event narratives are stories of single events that are subjectively meaningful and potentially self-defining moments in time—arguably the building blocks for the other kinds of narrative experiences. My dissertation helps demonstrate that the focus on event-level narratives is crucial if we are to better understand the other forms of narrative because of the nuanced relations between personal and health likely inform the other forms of narration.

These studies on personal narrative raise two important issues: 1) differential relationships of narrative forms to health; and 2) differential relations based on valence of event type. First, previous research has found four underlying factors to narrative expression: positive processing, negative processing, integrative meaning (e.g., growth), and structure (e.g., coherence, Graci, Watts, Fivush, 2018). All four factors related differentially to indices of well-being over and above traits (e.g. making meaning from events related to growing from experiences). The present research expanded on these findings by showing that coherence is likely related to direct forms of well-being, whereas narrative growth is related to indirect forms of well-being—such as emotion-regulation indices like self-compassion (Mansfield, Pasupathi, & Pals, 2015), post-traumatic growth (Graci & Fivush, 2017), ego development (King, Scollon, Ramsey, & Williams, 2000), and, in the present research, perceived stress. Second, the dissertation research expanded on these differential relationships by also demonstrating that event type adds another nuance to these relationships. In particular, negative event narrations might be a source for emotion-regulation levels since these narratives can aid in resolving

disruptive experiences (Mclean, Pasupathi, & Pals, 2007), whereas positive events might be a source for maintaining a basic level of well-being since these narratives can aid in founding positive self-views (Frederickson, 2004). Future work should look at these nuances in narrative relationships to health in order to better understand how narrating different kinds of events function in autobiographical memory and health.

My findings also caution against narrative aggregation of data, which is a common practice in the personality literature. For example, the "Life story interview" procedure, created by McAdams and colleagues, is an often-used methodology (McAdams, 1995). The procedure entails a two to three hour structured interview. Interviewers prompt participants to narrate about eight key episodes in their life (e.g. turning points in life, peak experiences, low points), as well as complete questionnaires concerning dispositional traits and health indices. Upon the completion of data collection, narratives are scored, using coding schemes, across the eight key episodes narrated. My findings of differential relationships between aspects of narrative and health for negative compared to positive experiences suggests that aggregating in this way most likely obfuscates important nuances in how narrative can help us better understand individuals' lived experiences.

Finally, the notion of enduring effects is not the only important question to ask in order to understand how and why narrative relates to health. Narration might have different effects on the self across time, what Bruner (1991) termed as *diachronicity*. Such diachronicity might be the case for negative event narration, and narrative meaning-making more broadly across development (e.g., Fivush, Booker & Graci, 2017). The underlying assumption here is that telling a healthy story might take time to create. One might incur short term consequences for long term gains when forming a coherent narrative account of negative events (Boals, Banks,

Hathaway, & Schuettler, 2011). Moreover, if narrative is a kind of maintenance mechanism for higher or lower health, the field first needs to better understand the consistency of narrative expressions over time. An increasing amount of research from both the narratitive identity and autobiographical memory literature has observed the moderate consistency of narrative expression—telling stories in a similar manner over time (Bauer, Tasdemir-Ozdes, & Larkina, 2014; Kober & Habermas, 2017; McAdams et al., 2006; Thorne, Cutting, & Shaw, 1998, Waters, Kober, Raby, & Habermas, 2018), which can, in turn, help better specify how and when it has an effect on health. The consistency of narrative expression, again, underscores the notion that people are actively remembering their personal experiences, not recollecting events as if they are being pulled from filing cabinets (Brockmeier, 2015). Collecting individuals' narratives provides researchers with insights into how people's experiences are actively reconstructed and retold over time

Remembering is a dynamic process. Every time a past experience is narrated to others, the local context of the retelling shapes how that remembering occurs and what will subsequently be remembered and retold (Brockmeier, 2015). From an autobiographical memory framework, such narrative processes are reconstructive. In particular, personal narratives are a dynamic "vehicle", or mechanism, for intergrating thoughts, feelings, goals, beliefs, reasoning processing, and the like to come together in a coherent storyline (Bruner, 1991, p. 7). The facts of the past event can't change, but how individuals organized and understood it through narrative processing can. A narrative mechanism may lead to a resolution in more manageable situations by creating order and coherence to one's personal events. Narrative processing, then, appears to be a functional mechanism to further understand and resolve the disruptive attributes of negative experiences, inform self-identity, and regulate narrators' emotions (McLean et al., 2007).

Personal narratives provide a window into how people are making sense of their experiences over time in the service of understanding themselves and their emotions.

References

Bauer, P. J., Tasdemir-Ozdes, A., & Larkina, M. (2014). Adults' reports of their earliest memories: Consistency in events, ages, and narrative characteristics over time. *Consciousness and Cognition, 27*, 76–88.

Bluck, S. (2003). Autobiographical memory: Exploring its functions in everyday life. *Memory, 11*, 113-123.

Boals, A., Banks, J. B., Hathaway, L. M., & Schuettler, D. (2011). Coping with stressful events: Use of cognitive words in stressful narratives and the meaning-making process. *Journal of Social and Clinical Psychology, 30*, 378-403.

Brockmeier, J. (2015). *Beyond the archive: Memory, narrative, and the autobiographical process*. Oxford University Press.

Bruner, J. (1991). The narrative construction of reality. *Critical inquiry*, 1-21.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives on psychological science, 6*, 3-5.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review, 107*, 261-288.

Firth, J. R. 1957. A synopsis of linguistic theory 1930-1955. *Studies in linguistic analysis*, 51: 1-31.

Fivush, R. (2011). The development of autobiographical memory. *Annu Rev Psychol, 62*, 559-582.

Fivush, R., Booker, J. A., & Graci, M. E. (2017). Ongoing Narrative Meaning-Making Within Events and Across the Life Span. *Imagination, Cognition and Personality, 37*, 127-152.

Fivush, R., & Graci, M.E. (2017) Autobiographical Memory. In: Wixted, J.T. (ed.), Cognitive Psychology of Memory, Vol. 2 of Learning and Memory: A Comprehensive Reference, 2nd edition, Byrne, J.H. (ed.). pp. 119–135. Oxford: Academic Press.

Fivush, R., & Nelson, K. (2006). Parent–child reminiscing locates the self in the past. *British Journal of Developmental Psychology*, *24*, 235-251.

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *359*, 1367-1378.

Gauld, A., & Stephenson, G. M. (1967). Some experiments relating to Bartlett's theory of remembering. *British Journal of Psychology, 58*, 39-49.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why?. *Current Directions in Psychological Science*, *13*, 1-4.

Graci, M. E., & Fivush, R. (2017). Narrative meaning making, attachment, and psychological growth and stress. *Journal of Social and Personal Relationships, 34*, 486-509.

Graci, M. E., Watts, A. L., & Fivush, R. (2018). Examining the factor structure of narrative meaning-making for stressful events and relations with psychological distress. *Memory*, 1-13.

Grysman, A. (2015). Collecting narrative data on Amazon's Mechanical Turk. *Applied Cognitive Psychology*, *29*, 573-583.

Habermas, T., & de Silveira, C. (2008). The development of global coherence in life narratives across adolescence: Temporal, causal, and thematic aspects. *Developmental psychology*, *44*, 707-721.

Harter, S. (1998). The development of self-representations. In N. Eisenberg & W. Damon (Eds.), Handbook of child psychology, 5th edition (Vol. 3, pp. 553–617). New York, NY: John Wiley and Sons.

Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: a latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General*, *133*, 189-217.

King, L. A., Scollon, C. K., Ramsey, C., & Williams, T. (2000). Stories of life transition: Subjective well-being and ego development in parents of children with Down syndrome. *Journal of Research in Personality, 34*, 509-536.

Köber, C., & Habermas, T. (2017). How stable is the personal past? Stability of most important autobiographical memories and life narratives across eight years in a life span sample. *Journal of personality and social psychology*, *113*, 608-626.

Lagattuta, K. H., & Wellman, H. M. (2001). Thinking about the past: Early knowledge about links between prior experience, thinking, and emotion. *Child Development*, *72*, 82-102.

Lilgendahl, J. P., Helson, R., & John, O. P. (2013). Does ego development increase during midlife? The effects of openness and accommodative processing of difficult events. *Journal of Personality*, *81*, 403-416.

Mansfield, C., Pasupathi, M., & McLean, K. (2015). Developing through difficulty: Does narrating growth of self in stories of transgressions promote self-acceptance and self-compassion? University of Utah: Salt Lake City.

McAdams, D. P. (1995). The life story interview. *Evanston, IL: Northwestern University*.

McAdams, D. P. (2008). Personal narratives and the life story. *Handbook of personality: Theory and research, 3*, 242-262.

McAdams, D. P., & Pals, J. L. (2006). A new Big Five: fundamental principles for an integrative science of personality. *Am Psychol, 61*, 204-217.

McLean, K. C., Pasupathi, M., & Pals, J. L. (2007). Selves creating stories creating selves: a process model of self-development. *Pers Soc Psychol Rev, 11*, 262-278.

Mikolov, T. Sutskever, I. Chen, K. Corrado, G. & Dean, J. (2013). Distributed representations of words and phrases and their compositionality. *Advances in neural information processing systems, 26*, 1081-1888.

Necka, E. A., Cacioppo, S., Norman, G. J., & Cacioppo, J. T. (2016). Measuring the prevalence of problematic respondent behaviors among MTurk, campus, and community participants. *PloS one, 11*, e0157732.

Pasupathi, M., & Wainryb, C. (2010). On telling the whole story: Facts and interpretations in autobiographical memory narratives from childhood through midadolescence. *Developmental Psychology*, *46*, 735, 746.

Peer, E., Vosgerau, J., & Acquisti, A. (2014). Reputation as a sufficient condition for data quality on Amazon Mechanical Turk. *Behavior research methods*, *46*, 1023-1031.

Thorne, A., Cutting, L., & Skaw, D. (1998). Young adults' relationship memories and the life story: Examples or essential landmarks?. *Narrative Inquiry*, *8*, 237-268.

Unsworth, N. (2010). Interference control, working memory capacity, and cognitive abilities: A latent variable analysis. *Intelligence*, *38*, 255-267.

Unsworth, N., & Spillers, G. J. (2010). Working memory capacity: Attention control, secondary memory, or both? A direct test of the dual-component model. *Journal of Memory and Language*, *62*, 392-406.

Waters, T. E., Köber, C., Raby, K. L., Habermas, T., & Fivush, R. (2018). Consistency and stability of narrative coherence: An examination of personal narrative as a domain of adult personality. *Journal of personality*, 1-12.