ABSTRACT

DUNSMORE, VICTORIA J. Coping with 'Scanxiety': Within-Person Adjustment Processes in Lung Cancer. (Under the direction of Dr. Shevaun D. Neupert).

Background: Lung cancer has the highest mortality rate for both men and women according to the American Cancer Society (2019). Patients with early-stage lung cancer undergo potentially curative therapy, while patients with advanced lung cancer receive medical therapy with the goal of prolonging survival and maintaining quality of life. In either setting, patients undergo regularly scheduled CT scans to determine if cancer has reappeared, spread, or stayed the same. This process is fraught with anxiety, coined 'Scanxiety'. The goal of the present project was to understand the within-person relationship between coping strategies and changes in scan-related anxiety among patients with lung cancer surrounding their scans. Most research in scan-related anxiety and coping examines coping and anxiety after the scan has already occurred. Here, I expand this to examine how coping and scan-related anxiety fluctuate in the months and days *before* one's scan.

Method: 25 individuals with lung cancer who had received curative intent treatment (*M* age = 62.33, [*SD* = 8.10], 96% women, 80% white) participated in the study. On the first day of the study, participants answered demographics surveys as well as their first monthly survey. In the monthly survey, they were asked questions about proactive coping and scan-related anxiety every 30 days until one week before their scan (total monthly surveys = 59). Participants then received 15 daily surveys for anticipatory coping and scan-related anxiety (i.e., 7 days before the scan, the day of, and 7 days after the scan), resulting in a total of 281 daily surveys available for analysis.

Results: Multilevel models revealed significant main effects of monthly proactive coping on monthly scan-related anxiety, such that on months when participants increased their use of

proactive coping, they also reported increases in scan-related anxiety for that month. There were also main effects of daily outcome fantasy and daily stagnant deliberation, two forms of anticipatory coping, on daily scan-related anxiety before and after one's scan. On days when participants reported increases in outcome fantasy and stagnant deliberation before one's scan, and increases in stagnant deliberation after one's scan, they reported increases in scan-related anxiety for that day. Finally, I found a significant interaction between age and problem analysis (another form of anticipatory coping), in predicting daily scan-related anxiety in the days before one's scan. Specifically, on days before the scan when middle-aged adults reported increases in problem analysis, they also reported increases in scan-related anxiety for that day.

Conclusion: These findings are the first to characterize how participants' coping and scanxiety fluctuate in the months and days *prior* to their CT scans. Results indicated that some common coping strategies currently being used in this sample may be maladaptive in nature, as reflected by increases in scanxiety. Intervention and implementation research should use this preliminary information to develop and test strategies to help intervene in the larger lung cancer population. Finding ways to help people adequately prepare for these stressful situations (i.e., CT scans) is crucial, as they will occur for the rest of their lives.

Coping with ‘Scanxiety’: Within-Person Adjustment Processes in Lung Cancer

by
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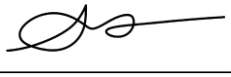

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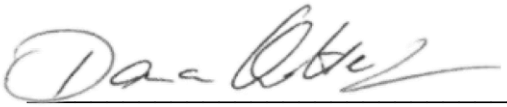

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DEDICATION

I would like to dedicate this dissertation to the woman who inspired and pushed me to learn more about cancer outcomes and survivorship due to her own personal battle with cancer, my mother, Tara Williamson. Being a first-generation college student, I would not have made it this far without her support and encouragement throughout my entire academic career. I would also like to dedicate this work to my family and friends who have pushed me to keep going during the challenging times and knew that I could make a difference in the cancer community with my work. I love you all.

BIOGRAPHY

My name is Victoria Dunsmore, and I am a Ph.D. Candidate in Lifespan Developmental Psychology at NC State University. I am currently in the process of completing my dissertation looking at coping and anxiety related to upcoming CT scans among patients with lung cancer. I was recently offered a position in a T32 postdoctoral program allowing me the opportunity to investigate age-related differences in breast cancer-related outcomes and their impact on daily anxiety and coping. I plan to eventually pursue a tenure-track faculty position at an R1 institution to begin mentoring graduate and undergraduate students, and continue research related to aging and psychosocial outcomes of cancer.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Shevaun Neupert, for her continued support and guidance to help me grow as an independent investigator. I would also like to thank Lyndsey Graham, for her assistance in data collection for my dissertation, as well as Dr. Edwin Fisher for his guidance in lung cancer research. Dr. Fisher also connected me to the Lung Cancer Initiative (LCI), who helped in the recruitment of patients with lung cancer, which made this project possible. I'd also like to acknowledge the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health, for awarding me the funding to recruit participants through Grant Award Number UL1TR002489. Finally, I wish to also acknowledge the Lifespan Developmental faculty and students for their advice and encouragement throughout my time at NCSU.

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CHAPTER 1

Background

With the highest mortality rate and the 2nd most diagnosed cancer (American Cancer Society [ACS], 2019), lung cancer causes substantial psychological morbidity that is important in its own right and often compromises treatment (Page & Adler, 2008). After treatment, patients undergo follow-up care as prescribed by their oncologist. This typically requires that they are screened for any cancer recurrence across the course of a few months to annually, depending on how soon they have received treatment (ACS, 2022). As one can imagine, undergoing these scans on a regular basis can lead to an increased level of anxiety in preparing for the results. The anxiety associated with these scans is so pervasive across all cancer types that it has been termed 'Scanxiety' (Feiler, 2011). Scanxiety is characterized by a fear that (1) current treatments have failed, as reflected by one's disease returning or progressing, (2) they may have to switch or add treatments, and (3) the fear of death (Portman, 2018). While most work has examined the prevalence or severity of scanxiety, little research has examined how scanxiety fluctuates in the context of one's scan (Bui et al., 2021a). A meta-analysis from Bui and colleagues (2021a) found that out of 57 studies examining scanxiety, only 14 reported a statistical comparison of scanxiety before and after one's scan, and the timing of the pre- and post- measurement varied from 4 weeks before to 1 year after. This is problematic as a patient may be going through scans frequently and so waiting an extended period to gather this information may lose the temporal sensitivity of scanxiety. Therefore, it is important to investigate the variability in anxiety and coping among those with lung cancer, in order to understand the ontogenetic nature of how one adjusts to their new routine for the rest of their lives after lung cancer treatment.

The anxiety one goes through in anticipation of their upcoming scan is fraught with various effects. Bauml and colleagues (2016) found that increased scanxiety among lung cancer patients with recurrent or metastatic non-small cell lung cancer (NSCLC) was related to impaired quality of life, specifically impacting emotional well-being. Bui et al., (2021b) also conducted a qualitative study and found common themes in the manifestations of scanxiety such as changes in mood, impaired concentration, and physical symptoms like insomnia and fatigue. While these symptoms are similar to those seen with general anxiety disorder (Substance Abuse and Mental Health Services Administration, 2016), scan-related anxiety is specific to a group of individuals who must undergo a common and recurrent stressor (i.e., CT scans) for the rest of their lives.

Health Systems Model of Stress and Coping

Health psychologists have long utilized models of stress and coping to understand how individuals cope with and adjust to various challenges that occur within a person's environment (Lazarus & Folkman, 1984; Moos & Schaefer, 1993), with the primary focus of understanding how one copes *after* experiencing a stressor. One of the most studied theories of stress and coping, proposed by Lazarus and Folkman (1984), emphasizes the importance of one's cognitive reappraisal of the stressful situation as an important antecedent in the coping process. Also significant in the transactional nature of stress and coping, is whether the perceived stressor is harmful or challenging, thereby presenting a threatening situation or an opportunity for growth (Lazarus & Folkman, 1984). The resulting reappraisal can promote emotion- (e.g., reducing negative emotions that result) or problem-focused (e.g., focused on resolving the stressful event or situation) coping, which may or may not be beneficial given the context it is in (Lazarus & Folkman, 1984).

Generally, coping research has examined how environmental or organizational factors are related to coping strategies between people; but researchers in the field of cancer adaptation have stressed the importance of looking at change in coping behaviors based on a specific stressor versus a broad category (Somerfield, 1997). This considers the unique circumstances that accompany specific stressful events, such as it is with patients with lung cancer and recurring CT scans. Somerfield (1997) termed this a micro-level approach in understanding cancer adaptation, as it allows researchers the ability to look at a specific, homogenous group of people, allowing work to be phenomena-driven versus method-driven. For example, individuals with lung cancer who have undergone curative-intent treatment and have CT scans every 6 months may vary in how they cope with upcoming scans based on how old they are, how long it has been since they have been diagnosed, as well as any family history of lung cancer. Therefore, while that group may be homogeneous in their ongoing treatment, these study designs allow researchers to understand the between-person influences that affect individual differences in coping.

While the between-person differences in coping with cancer are important, I argue that applied coping research can take an even more in-depth look at the person level. Specifically, examining a group of people with a unique stressor (e.g., CT scans) with similar characteristics (e.g., curative intent treatment - surgery, chemotherapy, etc.) across time to see how they *change* in relation to their own coping. This allows researchers to not only examine how person-level characteristics are related to coping and scan-related anxiety, but also how the relationship between coping and scanxiety changes across time. This also emphasizes the temporal significance of when the stressor occurs and when scanxiety occurs. For patients with lung cancer specifically, scanxiety has been shown to be at its highest in the week prior to one's scan and can persist in the week following (Bauml et al., 2016). Therefore, investigating the temporal

sensitivity of scanxiety and coping, also requires an understanding of developmental systems surrounding the individual.

Developmental Systems and Multilevel Investigations

Lifespan developmental research examines multidirectional, integrative processes that are informed and expanded on by multidisciplinary approaches (Baltes, 1987). In particular, how one interacts with their environment and how that shapes behavior in the context of cancer has been examined by areas of health psychology (Somerfield, 1997), public health (Francescutti et al., 2011), and biology (Mbemi et al., 2020). What is unique about the lifespan developmental framework, is its inclusion of a multilevel approach to understand how potential person-level or environmental factors influence within-person changes (Marshall et al., 2013). Gottlieb (2007) suggested that with developmental systems, it is less the focus of gene expression in predicting development, but rather the bidirectional influence at multiple levels including environment, behavior, and even neural activity. While most developmental systems work looks at how one's cultural, physical, or social environments influence person-level behavior, here I focus more on intraindividual variability, or within-person change, in scan-related anxiety, and how these may differ based on person-level factors.

Most work that examines intraindividual variability uses contemporary methods to capture information on a monthly or yearly basis. These methods aim to reflect within-person change across wider time periods and compare those fluctuations with others to see between-person differences in within-person change (Schaie & Caskie, 2005). Some concepts such as anxiety, stress, mood, and coping, have all been shown to fluctuate on a daily (anxiety: Pearman et al., 2021; coping: Neupert et al., 2016) or even a momentary basis (stress & mood: Yang et al., 2019). To fully understand the variability in monthly or daily scanxiety and coping prior to a

specific, unique stressor like CT scans, it's important to utilize methods that capture repeated measurements across time.

One such design that has been shown to reliably reflect the day-to-day fluctuations of concepts like coping and anxiety, is a daily diary design (Bolger et al., 2003; Neupert et al., 2016; Pearman et al., 2021). These methods are typically "self-report instruments used repeatedly to examine ongoing experiences" (Bolger et al., 2003, p. 580). Daily diary designs reduce the likelihood of retrospection and increase reliability and validity by reducing measurement error (Bolger et al., 2003). Scanxiety occurs prior to one's scan, so reducing retrospection is paramount as investigating this phenomenon involves looking forward, or preparing in advance, instead of looking back. Diaries help researchers get a better understanding of how one behaves in their natural setting; gathering information on "life as it is live" (Allport, 1942, p. 56). These methods also allow for a closer examination of intraindividual variability, as it gathers multiple points of information across a short timeline and establishes the within-person variability of concepts that had previously been thought to not fluctuate in the short-term (Bolger et al., 2003; Neupert & Bellingtier, 2018; Polk et al., 2020). Nesselroade (1991) describes intraindividual variability as short-term changes that can potentially be reversible, which is particularly important in applied coping research, as managing specific problems that occur daily is a primary goal in cancer adaptation intervention research (Somerfield, 1997).

Not only could these within-person fluctuations in anxiety and coping be important avenues for intervention work, but it could also reflect intraindividual change across time, such that variability in a short-time period could reflect a larger scale response from an individual as they encounter certain contexts multiple times across the lifespan (Nesselroade, 1991). For example, when looking at patients with lung cancer and their upcoming scans, the manifestations

of anxiety and coping that occur in the months or days before one's scan could, for better or worse, promote a cyclical pattern in how one approaches their scans for the rest of their lives. Given that these patients may have stable long-term trends in their coping and anxiety, it is important to understand the stability of these concepts in the months prior to a scan; but, as coping and anxiety have also been shown to fluctuate daily, understanding the instability is also critical.

Developmental and Health Systems in Coping with 'Scanxiety'

Health and developmental systems function together in shaping coping processes associated with scan-related anxiety; therefore, it is crucial to frame the health systems ideology within a developmental systems framework. As Nesselroade (1991) stated, "intraindividual change is complex, multidirectional, probabilistic, and does not transpire independently of its context" (p. 220). By bringing these areas of research together, I can investigate how two types of coping: *proactive*, more stable coping, and *anticipatory*, less stable coping, are related to both the long-term and short-term fluctuations in scan-related anxiety among patients with lung cancer in the months and days preceding their scan. By doing this, I scale down the scope of Somerfield's (1997) suggestion for applied coping research to aim at a specific problem towards a specific group, to examine within-person processes by using established methods in developmental systems work (e.g., daily diary research).

By framing health systems within a developmental systems framework, it is possible to understand how day-to-day changes in cancer-related outcomes may vary by environmental, situational, and even personal factors (see Figure 1). This idea expands on Moos and Schaefer's (1993) proposal that only looks at how meso- and macro-level factors are related to health, by considering the daily changes for these individuals in specific concepts related to unique

stressors (e.g., CT scans). Specifically, one can look more into the personal system (panel 2) to see how person-level factors, such as age, can impact within-person relationships of coping and scanxiety prior to a stressor on a monthly and daily basis. This fluctuation can then be impacted by environmental factors (panel 1) as well as relate to event-related factors (panel 3), general appraisal (panel 4), and finally well-being (panel 5). Using this model, researchers can examine how cancer outcomes vary daily and how these relationships differ between people by age. The current study will focus exclusively on age because of how the perception of time remaining in life, one's social clock, and the interpretation of the stressor influences motivation and behavior (Carstensen et al., 1999; Neugarten, 1976; Lazarus & Folkman, 1984).

Socioemotional selectivity theory, for example, posits that those with a limited time perspective will choose to engage in more emotionally-driven goals (e.g., focus on the present and maintaining positive relationships rather than build new ones) while those with an expansive time perspective choose more knowledge-driven goals (e.g., going out to make more friends or focusing on solving relationship problems) (Carstensen et al., 1999). Therefore, one's age and their anticipated length of life may change how they approach stressful situations. Among the cancer population specifically, women with metastatic breast cancer who have a limited time perspective preferred limited goals such as "spend more time with people important to me" rather than expansive goals "learn more about my disease and drugs" (Sullivan-Singh et al., 2015). For my sample of patients with lung cancer, this may be important to consider as lung cancer has the highest mortality of any cancer and may lead to limited perspectives and goals. Specifically, that they approach their upcoming scan dependent on how they perceive their time remaining in life.

Neugarten (1967) also described the idea of the social clock as being particularly relevant to those who experience significant life events at times in which they are not expected. For example, women undergoing menopause around the expected age range of their 40s and 50s did not report it as an unnatural or unexpected event, but rather, anticipated (Neugarten, 1976). In the cancer community, Costanzo and colleagues (2009) investigated how aging impacts psychosocial adjustment to surviving cancer across time and found that younger survivors (<63) experienced more psychological distress post-diagnosis, suggesting that being "too soon" with their diagnosis, or not at the expected age, was related to increased mental health issues.

Another developmental consideration are the differences in stress and coping across the lifespan. For example, a study done by Martins-Klein et al., (2021) looked at age differences in reported cancer-related stress and found that older adults reported less situation, social, and psychological stress at treatment compared to diagnosis. Gagliese et al., (2009) also examined age differences in cancer pain at one point in time and found that younger patients reported "waiting to live" versus "living despite pain". This reflects Lazarus and Folkman's (1984) transactional model of stress and coping as a way for individuals to potentially grow or be harmed from a stressor, dependent on how the individual perceives it and what resources they have. Therefore, coping may not always be beneficial, as one's environment may be too much for the individual's resources in how the appraise the situation. Laubmeier et al., (2004) examined this model as it relates to spirituality among patients with cancer to see if the benefits of spirituality change following the appraisal of the threat cancer poses to life. Interestingly, spirituality was found to be a useful resource and allowed participants to grow even in the face of cancer (i.e., better quality of life) (Laubmeier et al., 2004). This may be particularly relevant to

my sample of patients with lung cancer, as whether they view their diagnosis as an opportunity for growth or a threat to their longevity may impact how they approach scans.

While these theories reflect how where one is in the lifespan may relate to cancer outcomes, they both miss the nuance of how various age groups cope daily. Applied work must incorporate both between-person and within-person differences in coping, to tailor interventions to be the most effective in treating anxiety and depression on a daily basis (Yi & Syrjala, 2017); as the interpretation, timing, and resulting goals of life events can significantly impact how they interpret both their prognosis, as well as their continued treatment.

Before work can be done intervening with coping with CT scans to reduce scanxiety, a basic understanding of how these behaviors fluctuate needs to be established (Kerner et al., 2018). As discussed, most scanxiety work focuses on after the scan occurs (Bui et al., 2021a), but scanxiety can occur well before the stressor (Bauml et al., 2016). The current study aims to do just that, by examining two types of coping *prior* to the stressor occurring, as well as after the scan. I will investigate *proactive* and *anticipatory* coping in the months and days before a CT scan, as well as in the days after the scan, and see how they are related to scanxiety.

Proactive Coping

When considering the importance of temporal investigations of anxiety and coping for patients with lung cancer and their upcoming scans, one must consider more stable coping (proactive) and less stable coping (anticipatory) strategies for this upcoming stressor, rather than their reactive response to the stressor. This is because patients know that their scans are always upcoming, and as a result, experience great deals of stress and engage in behaviors to try and manage this stress and anxiety. Proactive coping is a type of coping where individuals engage in efforts to prevent or modify how a stressor unfolds; and is considered more stable over time

(Aspinwall & Taylor, 1997; see Appendix A). With this type of coping, individuals may not know when or how the stressor will occur and unfold, but they engage in activities or behaviors to help offset stressors before they develop (Aspinwall & Taylor, 1997). An important distinction between proactive coping and reactive coping is when the stressor occurs, as proactive coping involves *preparing in advance* and focusing on *future events* (Aspinwall & Taylor, 1997).

Proactive coping can be seen in the cancer screening process among individuals who carry a genetic marker for familial disease, and who engage in early detection and management efforts (Aspinwall, 2011). One example of this was explored by Botkin and colleagues (2003) who found that proactive coping efforts were utilized by individuals who carry a genetic marker for breast or ovarian cancer and engaged in early treatment to eliminate the risk of cancer developing (e.g., surgery), even though it may not develop at all. Aspinwall and Taylor (1997) suggested that some aspects of proactive coping involving recognition, such as worrying and hypervigilance (i.e., anxiety) of a problem, which is not sufficient to promote better outcomes and may be counterproductive. Instead, they suggest that active versus avoidant coping efforts can promote better outcomes (Aspinwall & Taylor, 1997). Therefore, acting early to eliminate the impact a potential stressor has on well-being, involves more than just recognizing the potential stressor.

In the context of patients with lung cancer and scanxiety, knowing that a problem may arise is not enough to promote healthy adjustment to lung cancer maintenance and treatment. While some research has examined proactive coping strategies in breast cancer patients (Fujimoto & Okamura, 2020; Lisica et al., 2019), these efforts are examined in between-person contexts, and proactive coping efforts are recorded only at one point in time. Patients with lung cancer are in a unique situation where they know a stressor may be upcoming but are not always

sure when it will occur (i.e., scheduling CT scans). Therefore, it is important to investigate how coping is reflected in this population across periods of time to see how it may fluctuate as a patient approaches their scan. While proactive coping is thought of as more stable, some research has found that it fluctuates across two time points (Miao et al., 2016), suggesting that repeated measurements across time may also reflect a similar trend. In the current study, I aimed to investigate proactive coping monthly, as it may shift but could remain relatively stable across time, relative to daily fluctuations. This type of coping also occurs prior to a stressful event, and therefore will not be measured after the scan. I am unaware of any work that looks at how those with lung cancer engage in proactive coping efforts in the months leading up to their scan, so this study is the first to allow proactive coping to vary month to month.

Anticipatory Coping

Unlike proactive coping, anticipatory coping may occur when an individual *knows when* an upcoming stressor will occur (Feldman & Hayes, 2005). While proactive and anticipatory both unfold before a stressor occurs, anticipatory coping involves targeted cognitive and behavioral efforts to prepare for a known upcoming stressor as it approaches (Feldman & Hayes, 2005). Feldman and Hayes (2005) designed the Measure of Mental Anticipatory Processes (MMAP), aimed at gathering four types of anticipatory coping that involve recurrent thought processes in preparation for the stressor; these include *plan rehearsal, problem analysis, outcome fantasy,* and *stagnant deliberation*. As is true in the transactional model of stress and coping (Lazarus and Folkman, 1984), not all forms of coping are helpful in reducing negative outcomes. Problem solving and accurately defining and analyzing the stressor, for example, (i.e., plan rehearsal and problem analysis, respectively) are thought to be associated with more positive outcomes, while thinking of the problem with no progress or avoidance of the problem (i.e.,

stagnant deliberation and outcome fantasy, respectively) are thought to be associated with negative outcomes (Feldman & Hayes, 2005). Examples of behaviors associated with these forms of coping can be seen in Appendix A. As Neupert et al., (2016) pointed out though, the beneficial nature of these coping efforts was investigated in between-person contexts and lack the understanding of within-person fluctuations across time.

There is some temporal evidence through of these fluctuations using contemporary longitudinal methods. Feldman and Hayes (2005) investigated anticipatory coping at two different time points, separated by 13 weeks, among a group of individuals known to be in a highly stressful environment (i.e., law students) and found that plan rehearsal predicted more positive thoughts towards the end of the semester, while outcome fantasy and stagnant deliberation were related to more negative thoughts. Neupert et al., (2016) took this one step further and examined the daily fluctuations of anticipatory coping with daily arguments among older adults and found that on days when older adults engaged in outcome fantasy, they reported decreases in well-being. Among the cancer population though, there is little research that examines anticipatory coping efforts in response to a known upcoming stressor, though some have examined this indirectly. When preparing for the known side effects of cancer treatments (e.g., hair loss) for example, Frith et al., (2007) found that the behaviors women engaged in strongly reflected that of anticipatory coping (e.g., affective and behavioral rehearsal). These findings were proposed to suggest that researchers find new ways to investigate anticipatory coping methods among those with cancer to promote better outcomes (Borsellino & Young, 2011; Somerfield, 1997).

Present Study

Understanding how coping strategies are related to levels of anxiety within-person, and how person-level factors influence this relationship, can inform larger studies to implement ways to prepare in advance to reduce scan-related anxiety associated with upcoming scans. This is critically important as patients with lung cancer have these scans for the rest of their lives (ACS, 2022). Past research is either cross-sectional or if longitudinal, based on only a few observations across a wider timespan (Bui et al., 2021a), so little is known about the process of coping and anxiety that unfolds within a person over time in relation to their upcoming scan. My lab is leading the field to focus on the temporal space before stressors through proactive and anticipatory coping mechanisms. Anticipatory and proactive coping are associated with better emotional outcomes (Neupert et al. 2016; Neupert & Bellingtier, 2019; Polk et al., 2020), and I extended this to scan-related anxiety by investigating how coping strategies and scan-related anxiety levels fluctuate relative to one's scan.

The primary aim of this work was to identify coping strategies that are related to low anxiety levels, if possible, within a person surrounding their scan. To do this, I tracked proactive and anticipatory coping efforts before and after lung cancer scans to evaluate how proactive and anticipatory coping strategies are related to levels of scan-related anxiety over time (see Figure 2). While no work has looked at how proactive and anticipatory coping relate to scan-related anxiety among patients with lung cancer, some work has shown how these types of coping are related to positive or negative outcomes. Therefore, I proposed the following hypotheses based on these trends in research.

First, I hypothesized that successful adaptation to scan-related anxiety in the months before one's scan (as reflected by low anxiety reports across time), will be the result of increased proactive coping. This is because proactive coping has been shown to be related to positive

outcomes among college students (Greenglass & Fiksenbaum, 2009; Grive & Anagnostopoulos, 2010), older adults (Neubauer et al., 2018; Sollár & Sollarova, 2009), and even cancer patients (Kesh Kumar & Bharti, 2021).

For daily anticipatory coping, I hypothesized that increases in stagnant deliberation and outcome fantasy would be related to poor adaptation before and after one's scan, as reflected by high levels of scan-related anxiety. In Figure 2, I provide an example of this relationship, with also a slight dip the day following the scan. The results of the scan are usually quick, (within 24 hours [Cleveland Clinic, 2020]) so if they receive good news, they may feel an initial relief or if they have not received the results, continued scanxiety. Research in the general population has shown that these types of coping are typically related to poor outcomes (Feldman & Hayes, 2005; Neupert et al., 2016), and I anticipated finding similar trends among those with lung cancer. Next, I hypothesized that increases in plan rehearsal and problem analysis will be related to decreases in scanxiety in the days before and after one's scan, which would reflect positive adaptation; though the only work I am aware of that shows this trend used between-person designs (Feldman & Hayes, 2005).

Finally, I wanted to examine some between-person differences, if possible, as my sample size was planned to be small (N = 25) and would therefore, limit the power to conduct between-person analyses. Given the previous relationships between age, coping, and cancer outcomes, I wanted to investigate whether the relationships between anticipatory or proactive coping and scanxiety are different across age. Being "on-time" or "too soon" with a cancer diagnosis can have different psychosocial effects dependent on where one is in the life-course. Neugarten (1976) discussed how we have a "social clock" that operates on certain aspects of our lives and serves as a guide for social age norms. For example, menopause is a period in life where women

go through extensive bodily changes, which can have a major impact on a women's identity (Neugarten, 1976). During cancer treatments, young women are sometimes thrown into premature menopause and therefore, report increased physical and psychological issues (Rosenberg & Partridge, 2013). While age in the current study is a proxy for age-related differences on coping and scanxiety, incorporating more aging factors are outside the scope of this project. Here, I intend to set the precedent that taking age-related factors into account when investigating cancer outcomes, can be used in future work to examine proactive coping, anticipatory coping, and scan-related anxiety across age groups.

CHAPTER 2

Methods

Participants and Procedures (Screening and Consent)

The current study was funded from a grant by the National Center for Advancing Translational Sciences (Grant award number UL1TR002489). I was able to receive this award thanks to a collaboration with my lab at NC State University, a clinical psychologist in the UNC School of Public Health, as well as with the Lung Cancer Initiative (LCI), a non-profit in central North Carolina. After receiving the grant, my team and I began the data collection process, where our co-investigators at LCI sent out a recruitment flier (see Appendix B) in their biweekly emails, as well as at events sponsored by LCI (e.g., Walk for a Cure 5K). To continue pushing recruitment, I also utilized snowball sampling. This involved emailing participants after they had completed the study to ask them to distribute the recruitment flier to other potential candidates. Through these methods my team and I recruited 25 participants (see Table 1 for demographics). If participants contacted researchers directly, I emailed them a link to complete the Qualtrics screening survey. The recruitment flier also had a QR code that would bring participants to the screening survey. The screener asked about the inclusion criteria, which were that participants must have been diagnosed with lung cancer, were within 6 months of their next scheduled scan, received curative intent treatment (i.e., intended to remove all cancer completely as it is localized via surgery, chemotherapy, etc.; ACS, 2019), were English speakers, were at least 18 years old, and were willing to provide their emails to be contacted for repeated assessments (see Appendix C). If participants indicated they would like to receive an informed consent, myself or the graduate research assistant reached out to them (by either phone or email) to schedule and conduct the consent call.

The research assistant and I alternated consent calls, and who we sent the monthly/daily surveys to. We confirmed the date of the upcoming scan during the phone call, and if participants were unsure of the exact date, we made a note of the expected month and emailed them a few weeks ahead of time to get the exact date. We also discussed the risks and benefits of the study, the purpose of the study, and compensation (i.e., $75 online gift card). During the phone call, participants indicated consent via an informed consent survey on Qualtrics and were emailed a copy of the consent document after agreeing to participate (see Appendix D). After indicating consent over the phone and in the Qualtrics survey, we started the data collection process.

Participants and Procedures (Day 1 and Monthly)

On Day 1, which was the day following consent, participants were sent emails at 6am EST that included the demographics survey and either their monthly survey or daily survey, dependent on whether their upcoming scan was within the next 30 days. These emails included the Qualtrics survey links, as well as their assigned personal participant identification number, which is sent to them in every follow-up email. These emails were modified to include either the link for the monthly only, the daily - before scan, the daily - after scan, or the follow-up survey Qualtrics links (see Appendix E). The prompts would modify slightly depending on the day it was sent (i.e., day of scan, last daily survey, follow-up survey and compensation). Participants were required to include their identification numbers before beginning any survey (i.e., demographics, monthly, and daily) to de-identify and track participant responses. In the emails, participants were instructed to complete these surveys before they go to bed. The date and time each survey was initiated and completed was recorded by Qualtrics.

The demographics survey asked questions regarding gender, age, race, education, marital status, personal and family cancer history (e.g., date of diagnosis, cancer site, treatment received,

and date of treatment received), scan history, date of upcoming scan, as well as questions regarding lung cancer stigma. The completion time for the demographics survey was approximately 10 minutes.

The monthly survey took about 5 minutes to complete and asked questions regarding proactive coping, scan-related anxiety framed in the context of the last 30 days, lung cancer-related quality of life, felt/ideal age, and coping efficacy. After sending the first monthly survey, researchers scheduled the additional monthly surveys (if applicable) to be sent every 30 days until the participant had less than 30 days before the week before their scan. For example, if an individual's scan was 45 days after consent (e.g., consent: March 30th), researchers sent the first monthly survey, then the second monthly survey 30 days later (April 29th), and finally, the first daily survey 7 days prior to the individual's scan (e.g., May 7th, with scan on May 14th). The response rate of the possible 59 monthly surveys sent out to the sample, had a 100% compliance rate.

Procedures (Daily Diary)

For the daily measures, participants received emails at 6am EST every day for 15 days. These emails asked them to complete the survey before they go to bed that night, as well as before their scheduled scan (on the day of). These surveys were sent starting seven days before the scan, the day of the scan, and every day after the scan for seven days. If the participants' scan was within 7 days of consent, researchers started Day 1 with the daily survey link and the demographic survey link. In the days following, they would only receive the daily survey link. It took participants approximately 5 minutes to complete each daily survey.

All daily surveys asked about anticipatory coping, scan-related anxiety framed for the past 24 hours, affect, daily stressors, daily physical symptoms, felt/ideal age, and finally two

items related to religious/spiritual coping. The final daily survey was indicated to the participants in the email, and they were told they would receive their follow-up survey the following day. Out of the possible 373 days of daily surveys for the participants, 281 were valid, resulting in a 75% response rate (see *Data Cleaning* for missing data procedure).

On the day after the last daily survey, participants were sent a follow-up questionnaire and were prompted to complete it before they went to bed that night. The follow-up survey asked about future time perspective, lung cancer stigma, and had an open-ended item for participants to add any information they felt was necessary about their results following the scan. If they indicated "yes", they provided an updated diagnosis and any additional information they felt was important to know regarding their scan and/or lung cancer diagnosis. Once I received the follow-up survey, I sent a $75 Vanilla VISA gift card via email to the participants' email account and thanked them for their participation.

Data Cleaning. Participants were only allowed one response per day; therefore, excess surveys received for a particular day were removed. Further explanation of data cleaning methods can be found in Appendix F.

Measures

For the purposes of this dissertation, I will be discussing the measures used in my analyses for the current project. The additional measures that may be used for future analyses are listed in Appendix G.

Demographics

Age. Participants were asked, "What is your age," and were prompted to type in a numerical response.

Monthly Measures

Proactive Coping. The 6-item Proactivity Scale from Aspinwall et al., (2005) was used to assess individuals' "preference for planning for adverse events and expending resources to prevent them or to reduce their impact" (p. 365). Participants were asked, "Rather than spending every cent I make, I like to save for a rainy day." and "Planning only makes a person unhappy, since plans hardly ever work out" (reverse scored). These items were answered on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Participants were assigned a monthly mean score for the scale, with higher scores signifying higher levels of proactive coping ($\alpha = .90$).

Scan-related Anxiety. The Impact of Event Scale (IES-6; Sundin & Horowitz, 2002) as modified by Bauml et al., (2016) for lung cancer scan screenings, examined monthly scan-related anxiety. It was modified for this study with a cognitive reset to reflect the last 30 days, and participants were asked to think about how distressing each difficulty (e.g., "I tried not to think about it" and "I had trouble concentrating") had been for the past 30 days with respect to their scan. Participants responded on a Likert scale of 0 (not at all) to 4 (extremely) and were assigned a monthly mean score for the scale, with higher scores signifying higher levels of scan-related anxiety ($\alpha = .85$).

Daily Measures

Anticipatory Coping. The 15-item adapted version (Neupert et al., 2016) of the Measure of Mental Anticipatory Processes (Feldman & Hayes, 2005), assessed coping with future stressful events. Two stressor domains were assessed: health and 'other', though for these analyses I focused on the health domain. The health-related prompt was modified to ask "Today, when you think about your upcoming scan, how often do you…", and respondents were presented with items related to four factors of anticipatory coping. After the scan, daily surveys

were modified to state "when you think about your recent scan". Five items related to *Problem Analysis* (e.g., "I think about why the problem is happening") (Before Scan α = .78; After Scan α = .78), three items related to *Plan Rehearsal* (e.g., "I think about the solution in a step-by-step fashion") (Before Scan α = .60; After Scan α = .53), five items related to *Stagnant Deliberation* (e.g., "I think about the problem without making progress on it") (Before Scan α = .79; After Scan α = .74), and two items related to *Outcome Fantasy* (e.g., "I daydream about the problem fixing itself") (Before Scan α = .44; After Scan α = .54), were presented. Each item was answered on a 5-point Likert scale ranging from 1 (never) to 5 (always). Daily mean composite scores were created for each of the four factors for each stressor with higher scores indicating a greater amount of anticipatory coping behaviors performed.

Scan-related Anxiety. The Impact of Event Scale (IES-6; Sundin & Horowitz, 2002) as modified by Bauml et al., (2016) for lung cancer scan screenings, was used to assess daily scan-related anxiety. This survey was modified with a cognitive reset to reflect the last 24 hours. Participants were asked to think about how distressing each difficulty has been for the past 24 hours with respect to their scan. Responses were on a Likert scale of 0 (not at all) to 4 (extremely) and included items such as "I tried not to think about it" and "I had trouble concentrating". Participants were assigned a daily mean score for the scale, and higher scores signified higher levels of scan-related anxiety (Daily: Before Scan, α = .85; Daily: After Scan, α = .69).

Analytic Strategy

I used multilevel modeling (MLM; Raudenbush & Bryk, 2002) to analyze repeated assessments within-person, focusing on changes in coping and scan-related anxiety on a monthly and daily basis. Multilevel modeling allowed participants to function as their own controls,

meaning their average scores were compared to their fluctuating reports. This method also allowed me to obtain estimates of person-level effects that may be related to within-person relationships between coping and scan-related anxiety. As some work has shown, age may be a significant between-person effect that can change how one copes with cancer (Gagliese et al., 2009; Martins-Klein et al., 2021). Therefore, given the wide age range of my sample, I planned to include age as a person-level factor; and while understanding interindividual differences in other person-level factors are important as well, they are outside the scope of the current project but are an important future direction.

With MLM I was also able to use all available data from each participant, regardless of their completion rate. I conducted separate models for the daily and monthly data where the within-person predictors were coping (*monthly*: proactive, *daily*: anticipatory), and the dependent variable was scan-related anxiety. With the daily models, I conducted 2 separate tests: before the scan and after the scan. This is to reflect the temporal sensitivity of scanxiety and coping before and after, in order to reflect a more pre/post framework of how patients with lung cancer deal with the scan. For the current study, coping prior to a scan is the less understood concept with scanxiety, but given that most research has shown reactive coping to a scan (Bauml et al., 2016; Bui et al., 2021a), I felt it was important to include this time period. In addition, participants may not receive the results of the scan on the same day, so therefore, just having the scan may not be enough to alleviate the scanxiety.

CHAPTER 3

Results

Descriptive statistics for the monthly and daily study variables are presented in Table 2. On average, participants responded around the high middle on the response scales for the scan-related anxiety measure and anticipatory coping subscales. Participants did, however, average higher scores on the proactive coping scale. For general cancer history information, 80% of the participants reported having at least one family member who had been diagnosed with cancer, of which 68% reported that at least one of these family member(s) had been diagnosed with lung cancer. For the year of the participants' initial diagnosis, they ranged from as early as July 2000 to as recent as December 2020. The participants' scan history showed that 60% of the participants had had at least 10 scans since their diagnosis, or so many that they could not remember the exact number, with the most recent scans being reported in the last year for all participants. This reflects that a large portion of the participants had extended experience with this process.

When reporting current CT scan outcomes, 72% of the participants chose to report their current CT scan results. These were open-ended items and of those who did respond, most reported "NED - No evidence of disease" or "Stable" (50%), some reported uncertain outcomes such as "was hard for them to read in parts" (22%), or that they needed additional treatment such as "having surgery" (11%). Some who opted in, did not provide any feedback (17%). Before beginning my main analyses, I person-mean centered the proactive coping and the anticipatory coping subscales to allow participants' responses to be compared to their own average for each scale, as well as to remove any between-person differences other than what I had included (i.e.,

age). Age was also grand-mean centered to create a meaningful 0 to be used in the analyses, by subtracting the sample mean age from each participant's age.

Unconditional Models

To begin the main analyses, I ran fully unconditional multilevel models on each of my outcome variables to ensure sufficient variability within-person (i.e., monthly and daily level) and between-person (i.e., person-level) to continue with my analyses (see Neupert, Miller, & Lachman, 2006; Raudenbush & Bryk, 2002). In a fully unconditional model, only the intercept is included with all other predictors left out (Curran, 2000; Nezlek, 2001). As I am examining 1 monthly and 2 daily models, I conducted 3 separate fully unconditional models on each of the outcomes – see equations below.

Monthly

$$\text{Level 1: Monthly\_Anxiety}_{it} = \beta_{0it} + r_{it}$$
$$\text{Level 2: } \beta_{0i} = \gamma_{00} + u_{0i}$$

Daily (Before Scan)

$$\text{Level 1: Daily\_Before Scan\_Anxiety}_{it} = \beta_{0it} + r_{it}$$
$$\text{Level 2: } \beta_{0i} = \gamma_{00} + u_{0i}$$

Daily (After Scan)

$$\text{Level 1: Daily\_After Scan\_Anxiety}_{it} = \beta_{0it} + r_{it}$$
$$\text{Level 2: } \beta_{0i} = \gamma_{00} + u_{0i}$$

The first unconditional model was conducted to determine the between- and within-person variability that existed in monthly scan-related anxiety. Results showed that 92% of the variability in monthly scan-related anxiety was between-person ($\tau_{00} = 1.13$, $z = 3.34$, $p < .001$) and 8% was within-person ($\sigma^2 = 0.10$, $z = 8.03$, $p < .001$). Next, were the unconditional models to determine between- and within-person variance in daily scan-related anxiety before and after one's scan. For before one's scan, results showed that 89% of the variability in daily scan-related anxiety was between-person ($\tau_{00} = 1.14$, $z = 3.38$, $p < .001$) and 11% was within-person ($\sigma^2 =$

0.14, z = 8.15, $p < .001$). For after one's scan, results showed that 78% of the variability in daily scan-related anxiety was between-person ($\tau_{00} = 1.16$, z = 3.16, $p < .001$) and 22% was within-person ($\sigma^2 = 0.33$, z = 8.06, $p < .001$). Therefore, all three of my unconditional models indicated that there was sufficient and statistically significant variability at the between- and within-person levels to continue with the planned analyses.

Monthly Model

To examine how proactive coping was related to scan-related anxiety in the months approaching one's scan, as well as how this relationship differs by age, I ran a non-random varying slopes multilevel model (see equation below). This model constrains the slopes from person to person, so that the within-person relationship between coping and anxiety varied only as a function of my person-level variable (i.e., age). Using the group-mean centered proactive coping score, I tested the relationship between proactive coping and monthly scan-related anxiety (γ_{10}), as well as whether there were age differences in this relationship (γ_{11}).

$$\text{Level 1: Monthly\_Anxiety}_{it} = \beta_{0it} + \beta_{1it}(\text{Proactive Coping}) + r_{it}$$
$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Age}) + u_{0i}$$
$$\beta_{1i} = \gamma_{10} + \gamma_{11}(\text{Age})$$

Results showed that on months when participants reported higher than their own average proactive coping, they also reported significantly higher scan-related anxiety for that month (see Table 3). However, there was no significant relationship between age and scan-related anxiety, and there were no age differences in the relationship between proactive coping and anxiety (see Table 3). The monthly reports of proactive coping and scan-related anxiety are depicted for every participant in Figures 3 and 4, respectively.

Daily Models

To see if anticipatory coping before and after one's scan was related to daily scan-related anxiety levels, I ran two non-random varying slope multilevel models (see equations below). As with the monthly model, I constrained the slopes from person to person and used the group-mean centered anticipatory coping scores (i.e., plan rehearsal, problem analysis, stagnant deliberation, and outcome fantasy). These models allowed me to see whether each of the anticipatory coping scales were uniquely related to daily scan-related anxiety (Plan rehearsal: γ_{10}, Problem Analysis: γ_{20}, Stagnant deliberation: γ_{30}, Outcome Fantasy: γ_{40}), and whether there were age differences in any of these relationships (Age x Plan rehearsal: γ_{11}, Age x Problem Analysis: γ_{21}, Age x Stagnant deliberation: γ_{31}, Age x Outcome Fantasy: γ_{41}).

Before Scan

$$\text{Level 1: Daily\_BeforeScan\_Anxiety}_{it} = \beta_{0it} + \beta_{1it}(\text{Plan Rehearsal}) + \beta_{2it}(\text{Problem Analysis}) + \beta_{3it}(\text{Stagnant Deliberation}) + \beta_{4it}(\text{Outcome Fantasy}) + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Age}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(\text{Age})$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21}(\text{Age})$$

$$\beta_{3i} = \gamma_{30} + \gamma_{31}(\text{Age})$$

$$\beta_{4i} = \gamma_{40} + \gamma_{41}(\text{Age})$$

After Scan

$$\text{Level 1: Daily\_AfterScan\_Anxiety}_{it} = \beta_{0it} + \beta_{1it}(\text{Plan Rehearsal}) + \beta_{2it}(\text{Problem Analysis}) + \beta_{3it}(\text{Stagnant Deliberation}) + \beta_{4it}(\text{Outcome Fantasy}) + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Age}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(\text{Age})$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21}(\text{Age})$$

$$\beta_{3i} = \gamma_{30} + \gamma_{31}(\text{Age})$$

$$\beta_{4i} = \gamma_{40} + \gamma_{41}(\text{Age})$$

'Before Scan' Model

Results showed that on days before one's scan when participants reported higher stagnant deliberation than their own average, as well as higher outcome fantasy than their own average, they also reported significantly higher scan-related anxiety for that day (see Model 1 of Table 4). However, there was no significant relationship between age, problem analysis, or plan rehearsal

and scan-related anxiety before one's scan. Interestingly though, I found a significant interaction between problem analysis and age in predicting scan-related anxiety before one's scan. Specifically, on days before the scan, when middle-aged participants reported more problem analysis, they also reported increases in scanxiety for that day (see Figure 5). The daily reports of outcome fantasy, stagnant deliberation, problem analysis, and scan-related anxiety for each participant are depicted in Figures 6, 7, 8, and 9, respectively.

'After Scan' Model

On days after one's scan when participants reported more stagnant deliberation, they also reported significantly higher scan-related anxiety for that day (see Model 2 of Table 4). However, there was no significant relationship between problem analysis, plan rehearsal, outcome fantasy, or age in predicting scan-related anxiety after one's scan. I also found no significant interactions between age and the four anticipatory coping subscales in predicting scan-related anxiety in the days after one's scan (see Model 2 of Table 4). The daily reports of stagnant deliberation and scan-related anxiety for each participant are presented in Figures 10 and 11, respectively.

CHAPTER 4

Discussion

The goal of the present study was to investigate how coping (proactive and anticipatory) and scan-related anxiety fluctuate among patients with lung cancer in the months and days prior to their CT scans, as well as in the days after their CT scans, and how age may impact these relationships. While the unconditional models showed that the within-person variability to be explained in scan-related anxiety was relatively small, this work is important to the hundreds of thousands diagnosed with lung cancer. The fact that scanxiety is not stable and fluctuates day-to-day, suggests that it can be intervened and improved on for this population, as suggested by Nesselroade (1991).

My results showed significant main effects for proactive coping and two types of anticipatory coping (i.e., stagnant deliberation and outcome fantasy) in predicting monthly and daily scan-related anxiety, though I did not find a main effect of age. I did, however, find a significant interaction between age and one form of anticipatory coping (i.e., problem analysis) in predicting scan-related anxiety in the days prior to one's scan. Specifically, on days before their scan, if middle-aged adults engaged in more problem analysis they reported increases in scan-related anxiety for that day.

Monthly Main Effects

I examined how patients with lung cancer prepared months in advance with their scan, through proactive coping (see Appendix A). Past research has shown that proactive coping is related to better outcomes such as lower levels of depression among college students (Greenglass & Fiksenbaum, 2009). It has also been shown among college students to mediate the relationship between optimism and trait anxiety, such that more optimism promotes more proactive coping

which in turn reduces anxiety (Grive & Anagnostopoulos, 2010). Little work has looked at cancer populations when examining proactive coping and anxiety, but one study involved recruiting arsenic induced cancer patients in Bihar, India (Kesh Kumar & Bharti, 2021). In Bihar, there were massive amounts of arsenic contamination of the groundwater that created a public health crisis; therefore, researchers wanted to assess proactive coping and how it related to stress, anxiety, and depression in this population (Kesh Kumar & Bharti, 2021). Results showed that more proactive coping was related to low levels of all three of these psychological morbidities (Kesh Kumar & Bharti, 2021). Proactive coping has also been shown to be used more by older adults, and related to positive outcomes (Neubauer et al., 2018; Sollár & Sollarova, 2009). Interestingly, in my population of patients with lung cancer, I did not find a negative association between proactive coping and scan-related anxiety, nor did I find a significant relationship between age and proactive coping. Rather, I found that increases in proactive coping in the months prior to one's scan were associated with increases in scan-related anxiety for that month, but this relationship did not differ by age.

Given the discrepancy in my findings compared to most proactive coping work, it's important to consider that proactive coping is typically measured at one point in time and here I used repeated measures of proactive coping over long periods of time. Even though proactive coping is thought of as more stable, some research has looked at how proactive coping fluctuates over time. For example, Miao et al., (2016) used a micro-longitudinal design to examine daily meaning in life and proactive coping. They measured proactive coping at 2 time points, separated by the span of 3 weeks, and found that the rate of change of meaning of life predicted change in proactive coping over time (Miao et al., 2016). My study takes the change over time in proactive coping further and captures it every 30 days, which may be why I found different results. This

change over time in my sample suggests that if levels of proactive coping are high over time among those with lung cancer, it may lead to counterproductive outcomes.

I am not aware of current research that has found negative outcomes of proactive coping, but Aspinwall and Taylor (1997) suggest that some aspects of proactive coping may be related to poor outcomes. For example, proactive coping requires resource allocation to prepare for a stressor, and if the stressor does not occur or the wrong resources are used, the coping efforts will be depleted when the stressor actually occurs (Aspinwall & Taylor, 1997; Schönpflug, 1986). For my sample of patients with lung cancer, they may already be low on resources as they prepare for an upcoming scan. Therefore, if they engage in proactive coping too often, they exhaust their resources and can experience negative outcomes. This can be further examined through my proposed framework (see Figure 1), as the lack of resources on a monthly basis may be impacted by other person-level factors not examined here. Therefore, these could influence one's health and well-being and relate to poor outcomes for the individual. Future work should continue to examine this relationship and how it is influenced by these factors.

Daily - Before Scan Main Effects

In line with one of my daily hypotheses, I found a significant main effect of anticipatory coping in predicting scan-related anxiety. Specifically, I found that increases in outcome fantasy and stagnant deliberation were related to increases in scanxiety in the days before one's scan, after controlling for other forms of anticipatory coping. Past research has shown that increased behaviors such as distraction and normalization increase in the days before one's scan (Bui et al., 2021b). These behaviors are similar to how Feldman and Hayes (2005) defined outcome fantasy - fantasizing desired outcomes and ignoring details of problem-solving. Stagnant deliberation consists of thinking about the problem without making progress on it (Feldman & Hayes, 2005).

Similar to stagnant deliberation, rumination has also been shown to be related to increased levels of anxiety and depression in patients with cancer who were in remission (Liu et al., 2018); yet rumination is more backward focused. This means that with increases in these behaviors, and their relationship to increased levels of depression and anxiety (Feldman & Hayes, 2005), it would not be surprising that these types of anticipatory coping are also related to scan-related anxiety when the stressor has been defined.

I did not find a significant main effect of age, or an interaction between age and all types of anticipatory coping, except for problem analysis (see *Daily Interaction - Age & Problem Analysis*). Age and anticipatory coping have been shown to be related when examining daily coping for various stressors (Neupert & Bellingtier, 2019). Outcome fantasy, specifically, has been shown to have a lagged effect in predicting physical symptoms the following day with older adults (Neupert et al., 2016). These studies had a larger sample of participants from the general older adult population, which may explain why my results did not reflect this. Also unique to my sample, was that I was not measuring daily average stressors or stressor types. My work was focused solely on patients with lung cancer approaching CT scans, and therefore, coping with scanxiety may function differently with this population, including increased fantasizing about better outcomes for the scan. This is essential to consider, as my framework (see Figure 1) suggests that these relationships may impact overall health and well-being for the individual; and as these are repeated and continued experiences, it's important for intervention work to understand this relationship.

Daily - After Scan Main Effects

For the after scan main effects, I found results consistent with one of my hypotheses: on days when participants reported more stagnant deliberation, they also reported higher levels of

scan-related anxiety for that day, after controlling for other forms of anticipatory coping. I did not find a significant interaction between age and anticipatory coping in the days after one's scan. As the unconditional model showed, there was a significant amount of within-person variability to be explained in scanxiety in the days after the scan. Interestingly, there was more within-person variability to be explained after the scan, than there was before the scan. This may be because in the days prior to a scan, patients reflect similar trends of scanxiety from day-to-day (i.e., generally high or increasing), and therefore, comparing to their own average does not tell us as much as comparing each person's coping to each other. In the days after the scan, one's anxiety may be more generalized since the scan has already passed and they have received their results, thus impacting how they adjust to their individual outcomes.

As Feldman and Hayes (2005) defined it, stagnant deliberation consists of dwelling on a problem and experiencing unproductive thoughts about it, which can be related to poor outcomes (Neupert et al., 2016). Similar to stagnant deliberation, rumination can be related to increased mental health problems (Liu et al., 2018), which may be particularly relevant to those with lung cancer who have just had their CT scans, are waiting for their results, and are ruminating, which emphasizes the backward-looking nature of rumination. Participants in my sample had received curative intent treatment, and the majority showed no sign of disease or stability in their scans, yet I still found high rates of scanxiety before and after their scan. Bauml et al., (2016) found that scanxiety can take place before and after one's scan, suggesting that even finding no evidence of disease progression may not be as reassuring to the patient, which supports my current findings. This means that even though patients with cancer may have their results, and they are good results, it's still important to promote positive coping mechanisms, as stagnant deliberation may lead to increases in scanxiety even after the scan.

Daily Interaction - Age and Problem Analysis

Interestingly, I only found one interaction between age and coping as it relates to daily scan-related anxiety. Specifically, on days before one's scan if middle-aged adults reported increased levels of problem analysis, they also reported increases in scan-related anxiety for that day, after controlling for other forms of anticipatory coping. Referring to the proposed theoretical framework (Figure 1), this interaction shows that age (i.e., person-level factors bubble) can significantly impact the relationship between daily coping and scanxiety. This may lead future work to consider how coping and scanxiety is impacted by environmental factors (panel 1), as well as how it predicts later health and well-being (panel 5). Several factors are important to review in this interaction, the first being the meaning of problem analysis and how it is utilized among middle-aged adults.

Problem analysis involves the active contemplation and meaning of the problem in future stressful situations (Feldman & Hayes, 2005). Some aspects of problem analysis, including accurately defining the problem, are essential in problem-solving interventions used to treat depressive and/or anxiety disorder (Zhang et al., 2018). Yet, middle-aged adults in my study (i.e., 1 *SD* below *M*) reported increases in scan-related anxiety when using this strategy compared to older adults. Part of the benefit of problem analysis is that it involves accurately defining the problem and allows the individual to gain insight into the experience, which clinicians can use in clinical interventions (D'Zurilla & Nezu, 2001; Stiles et al., 1990). This process may get complicated when looking at those with cancer who see the problem as an abnormality in their aging process and fixate on it. Cancer has progressively been diagnosed in adults younger than the average age of 65; and as a result, the field of geriatric oncology was established to investigate how aging, and cancer are related to outcomes (Blank & Bellizzi,

2008). When cancer or other major life events are not 'on-time' with when it is expected in the lifespan, it can elicit great deals of anxiety and other mental health problems (Jones et al., 2014; Neugarten, 1976; Park et al., 2018). For patients with lung cancer, this could be amplified if they are not able to explain their diagnosis through other factors (e.g., no history of smoking, no family history of lung cancer, etc.). Therefore, when this age group tries to analyze and make sense of the problem, they are unable to and may perpetuate that anxiety when they think about their upcoming scan.

Another important factor in this interaction is the temporal point, as it occurred in the days prior to one's scan. As previously mentioned, scanxiety can be at its highest in the days prior to one's CT scan for lung cancer patients (Bauml et al., 2016). Patients with cancer approaching their CT scans also do not know what the scans will say, and therefore, the appropriate action to take may not be clear. By engaging in problem analysis before one's scan, middle-aged patients with lung cancer appear to be trying to define the problem at hand, without coming to a reasonable conclusion before their scan, which could increase their levels of scan-related anxiety.

Limitations and Future Directions

While this study was the first of its kind to track how coping efforts are used to prepare for a unique stressor (i.e., CT scans), there were some limitations. The first being that the problems defined in the anticipatory coping and proactive measures may not have been interpreted by the participants in the way we had hoped. The proactive coping (Aspinwall et al., 2005) and anticipatory coping (MMAP; Feldman & Hayes, 2005) measures have not been used on a cancer population before, or with a cancer treatment-related stressor, but instead have been used to investigate general or domain-specific stressors (Neupert et al., 2016; Neupert &

Bellingtier, 2019; Polk et al., 2020). I had modified the cognitive resets to not only reflect the accurate time period (e.g., "the last 30 days"), but also the stressor itself (e.g., "when thinking about your upcoming scan"), but I did not modify any of the items. When thinking of the 'problem' participants may have read the items in relation to their diagnosis, rather than their upcoming scan. In the anticipatory coping measure, items from the problem analysis subscale such as 'analyze the source of the problem' or 'try to understand how the problem arose', may not be accurate when discussing scans, as that is a constant, mostly unavoidable activity after treatment. I also found low reliability with the 2 items in the outcome fantasy subscale of anticipatory coping, which may be due to the low sample size. Future research should continue testing these items, or conduct community feedback work on the measures, within larger lung cancer populations to investigate the validity and reliability of these items. It may also be good practice to include qualitative items related to coping in order to get a more personalized look at how individuals view the 'problem', as scanxiety focuses on what the scan tells them about their lung cancer (i.e., lung cancer focused) and if they view the 'problem' as their lung cancer versus the scan.

Another limitation of this study was that I was unable to investigate many between-person differences between participants, due to the homogenous nature of my small sample. Multiple factors can influence how one deals with their scanxiety as they approach their scans. Cancer stage is related to coping strategies as a systematic review showed that individuals with advanced cancer diagnoses engaged in more emotion-focused versus problem-focused coping (Thomsen et al., 2010). There is also the consideration that most of my sample had had at least 10 scans since their diagnosis, suggesting extensive experience and familiarity with this process. Yet even though my group had experience with CT scans, I still found significant levels of

coping and scan-related anxiety, supporting the claim that scanxiety is a persistent and invasive experience (Bauml et al., 2016). What extensive experience with scans may suggest among patients, is that individuals have changed their forms of coping over time. Even if their scanxiety is still high, they may have tried other forms of coping which should be further investigated in future work.

Cancer-risk history can be an important influence in how one adjusts to their cancer, as those with a history of smoking or a family history of lung cancer may see this outcome as a potential possibility for themselves. This can be tested in the proposed theoretical model (Figure 1) with the different person-level factors as well as how they may be impacted by environmental or structural factors. While the results of this work describe a very small subset of patients with lung cancer, it provides enough support for researchers to recruit a national sample of participants and track similar outcomes. Given that lung cancer is the 2nd most diagnosed cancer in the U.S. (ACS, 2019), it is important to cast a wider net with recruitment. This will allow researchers to adequately investigate between-person differences as the unconditional models of scan-related anxiety tested here showed that a large portion of the variance in scan-related anxiety can be explained by person-level differences.

Applications

While this study has some limitations, there are various clinical applications that can be used in intervention and implementation research. Scanxiety is a persistent and intense experience for those who are either battling or have overcome their cancer diagnoses yet are still undergoing regular CT scans. Regardless of the outcomes of the scan, scan-related anxiety can continue to cause distress to cancer patients (Bauml et al., 2016); and while clinicians and patients alike recognize the importance of understanding scanxiety, little work has examined

how it fluctuates in the months and days prior to the scan (Bui et al., 2021b). This means that intervention and implementation work cannot occur without a clear understanding of the problem. In the current study, I examined coping and scanxiety trends that future intervention work should consider when tailoring coping interventions. Particularly, what coping strategies were related to poor outcomes among those with lung cancer (i.e., outcome fantasy or stagnant deliberation). This work also showed that for certain age groups, certain coping strategies (i.e., problem analysis) may be associated with increased scanxiety. Intervention and implementation work should continue to investigate which types of coping strategies are useful in reducing scanxiety for individuals of certain age groups.

Conclusion

This study was the first of its kind to investigate how scanxiety and coping fluctuate among a population who encounter CT scans on a frequent basis, as well as understand how age plays a role in this relationship. By proposing a conceptual framework that intertwines health and developmental systems, I could examine how a cancer population deals with a unique and specific stressor using a micro-longitudinal design to understand real-world experiences of scan-related anxiety. A key takeaway of this work is that patients with lung cancer need help in managing their anxiety in the months and days prior to, as well as after, their scans. Lung cancer impacts a large portion of U.S. citizens, as it is the 2nd most diagnosed cancer (ACS, 2019), so finding ways to reduce these poor outcomes needs to be paramount in cancer outcome research

Table 1

Demographics of Participants at Baseline

	N	%
Gender		
Women	24	96
Men	1	4
Race		
African American or Black	3	12
White	20	80
Asian or Asian American	1	4
Multi-racial	1	4
Marital Status		
Single (never married)	1	4
Married/Domestic Partnership	14	56
Widowed	2	8
Divorced	8	32
Education		
High school or equivalent (e.g., GED)	3	12
Some college, no degree	11	44
Associate degree	3	12
Bachelor's degree	4	16
Master's degree	2	8

Note. $N = 25$. Participants ranged in ages from 43 to 78, with an average age of 62.33 (SD = 8.10). All percentages add up to 100% for each demographic variable.

Table 2

Descriptive Statistics of all Study Variables (N = 25)

		M(SD)
Between-Person		
	Age	*62.33*(8.10)
Monthly		
	Proactive Coping	*4.11*(0.48)
	Scan-related Anxiety	*2.85*(1.05)
Daily (Before Scan)		
	Anticipatory Coping Scales	
	Outcome Fantasy	*2.84*(1.44)
	Problem Analysis	*2.41*(1.21)
	Plan Rehearsal	*2.38*(1.22)
	Stagnant Deliberation	*2.12*(1.07)
	Scan-related Anxiety	2.79(1.06)
Daily (After Scan)		
	Anticipatory Coping Scales	
	Outcome Fantasy	*2.68*(1.41)
	Problem Analysis	*2.24*(1.22)
	Plan Rehearsal	*2.21*(1.14)
	Stagnant Deliberation	*1.96*(1.15)
	Scan-related Anxiety	*2.32*(1.08)

Note. Averages are between-person.

Table 3

Unstandardized Coefficients (Standard Errors) of Multilevel Models of Monthly Proactive Coping and Anxiety

Effect	Parameter	Model 1
Monthly scan-related anxiety, β_0		
Intercept	γ_{00}	2.85**(.22)
Age	γ_{01}	-0.03(.25)
Monthly slope constrained, β_1		
Proactive coping	γ_{10}	0.28*(.12)
Proactive coping*Age	γ_{11}	-0.001(.02)
Random Effects		
Variance components		
Monthly scan-related anxiety (τ_{00})		1.11**(.34)
Within-person fluctuation (σ^2)		0.10**(.01)

Note. *p<.05; **p<.001.

Table 4

Unstandardized Coefficients (Standard Errors) of Multilevel Models of Daily Anticipatory Coping and Anxiety

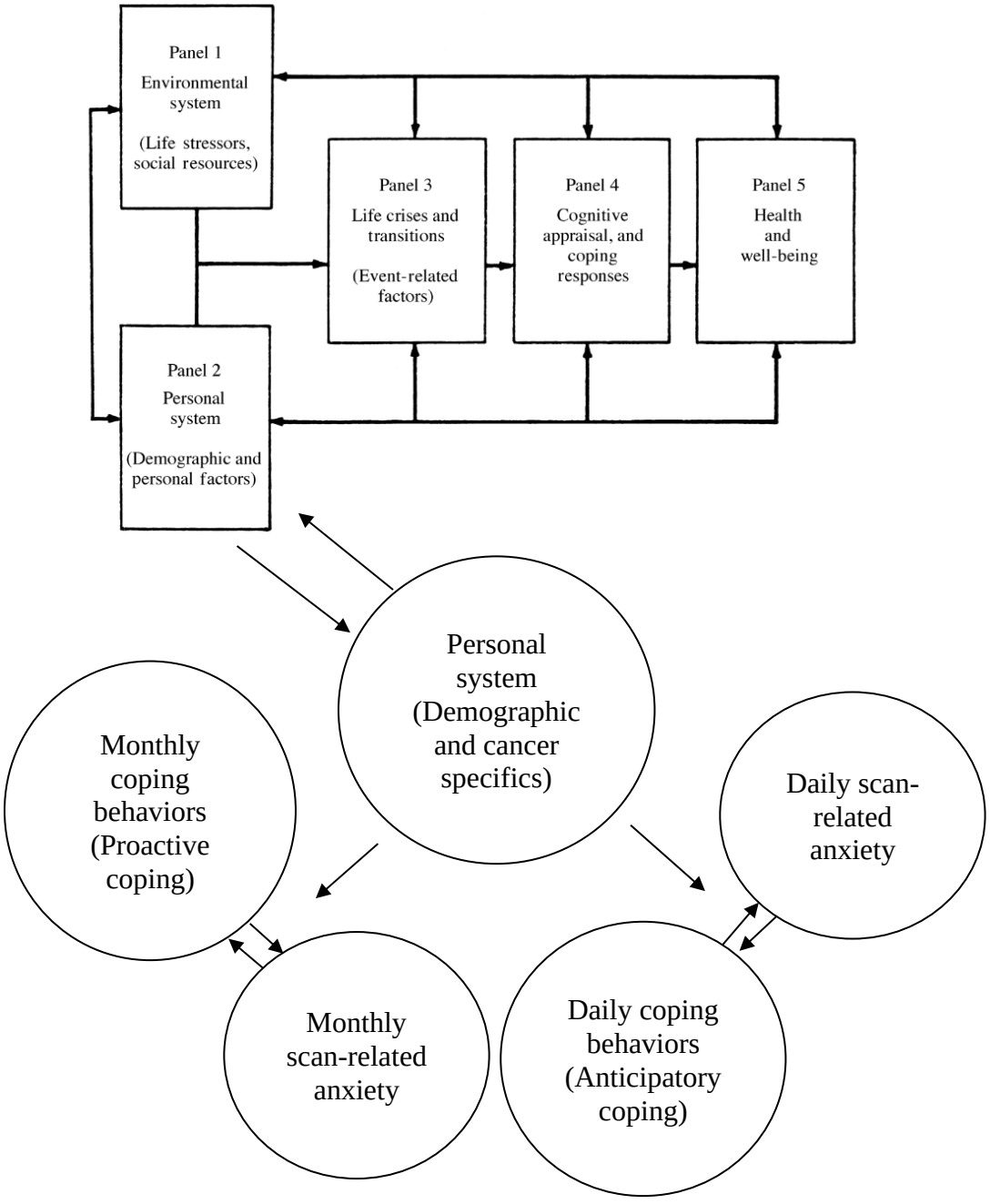
Effect	Parameter	Model 1 (Before Scan)	Model 2 (After Scan)
Daily scan-related anxiety, β_0			
Intercept	γ_{00}	2.79***(.22)	2.34***(.24)
Age	γ_{01}	-0.01(.03)	-0.02(.03)
Plan rehearsal slope constrained, β_1			
Plan rehearsal	γ_{10}	0.03(.08)	0.12(.12)
Plan rehearsal*Age	γ_{11}	0.01(.02)	-0.02(.02)
Problem analysis slope constrained, β_1			
Problem analysis	γ_{20}	.05(.08)	0.09(.13)
Problem analysis*Age	γ_{21}	-0.04**(.01)	-.01(.02)
Stagnant deliberation slope constrained, β_1			
Stagnant deliberation	γ_{30}	0.19*(.08)	0.48***(.14)
Stagnant deliberation*Age	γ_{31}	-0.001(.01)	0.03(.02)
Outcome fantasy slope constrained, β_1			
Outcome fantasy	γ_{40}	0.13*(.05)	0.09(.09)
Outcome fantasy*Age	γ_{41}	0.0001(.01)	-0.01(.02)
Random Effects			
Variance components			
Daily scan-related anxiety (τ_{00})		1.19***(.36)	1.21***(.39)
Within-person fluctuation (σ^2)		0.13***(.02)	.28***(.04)

Note. Model 1 refers to the Before-scan Results and Model 2 refers to the After-scan outcomes.

*p<.05; *p<.01; ***p<.001.

Figure 1

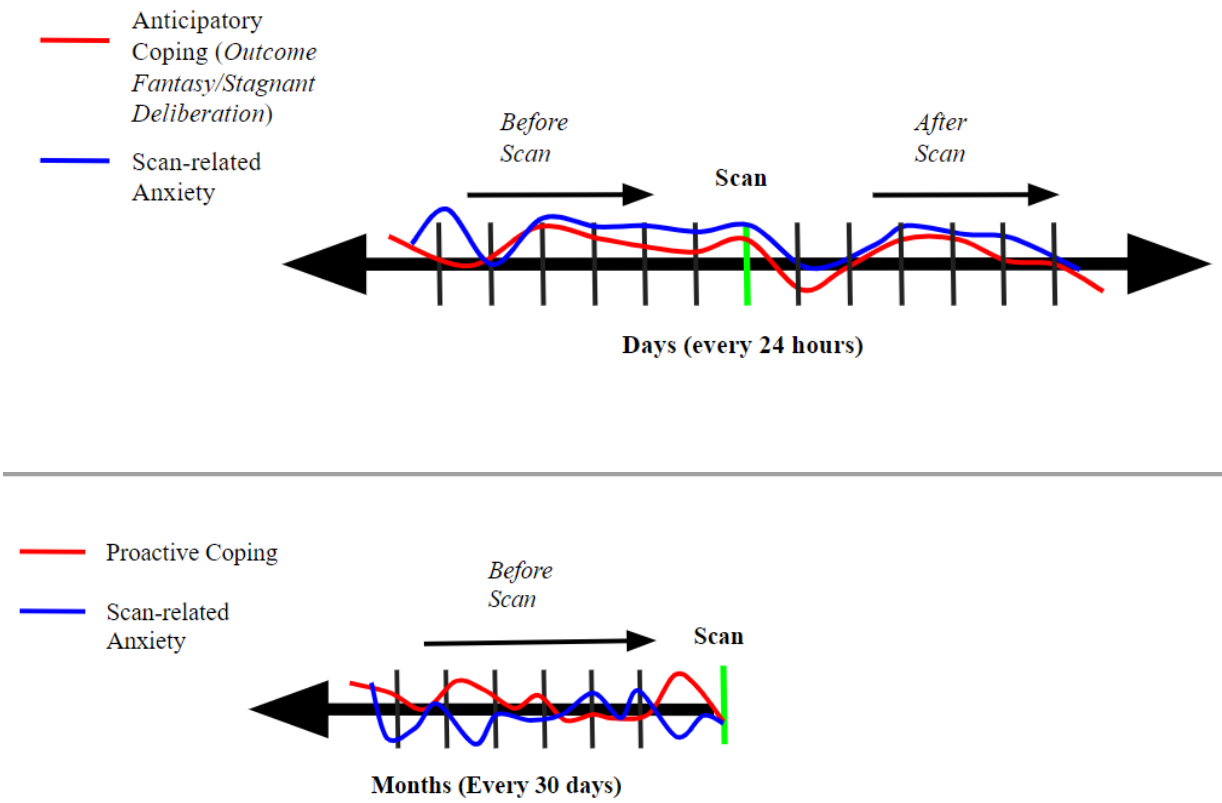
Conceptual Framework: Within-person Focus on Scanxiety and Coping



Note. Expanded from Moos and Schaefer's (1993) integrated conceptual model of stress and adaptation; I propose examining the within-person fluctuations in coping and anxiety, and how they are influenced by between-person characteristics.

Figure 2

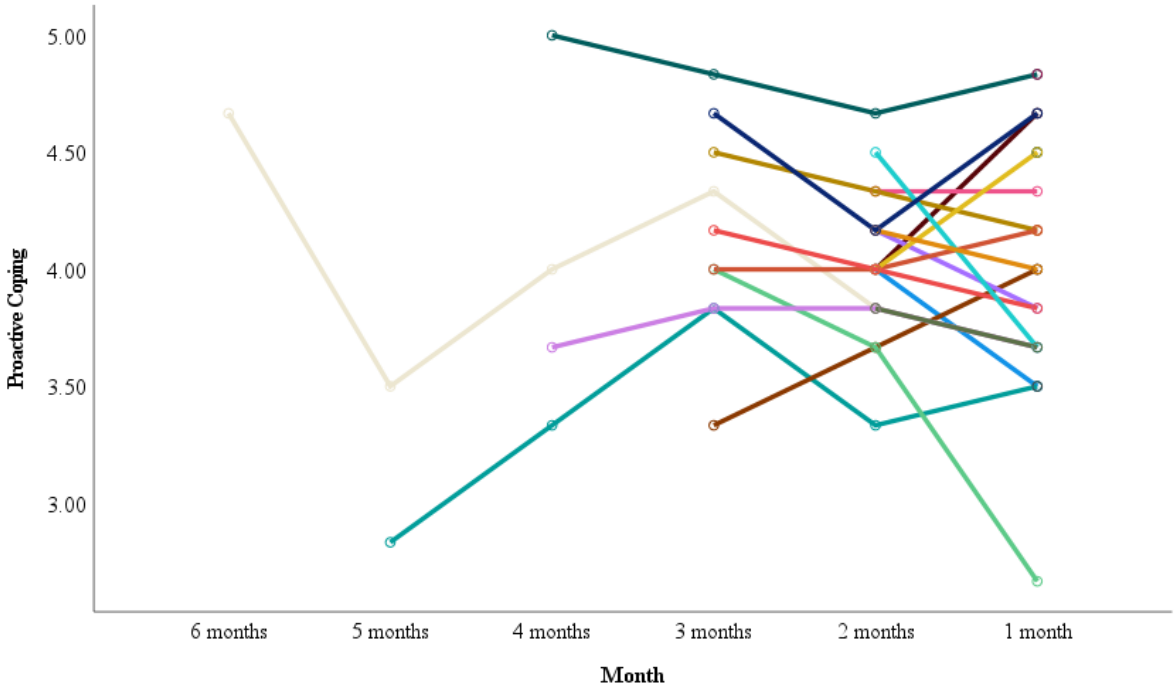
Hypothesized Monthly and Daily Modeling of Coping and Scanxiety Tracking



Note. The first continuum is an example of hypothesized patterns of daily outcome fantasy or stagnant deliberation, and scan-related anxiety. As proposed, high levels of these types of anticipatory coping are thought to be related to high levels of scanxiety. The second continuum is an example of the hypothesized pattern of monthly proactive coping and scan-related anxiety. As proposed, higher levels of proactive coping are expected to be related to low levels of scanxiety.

Figure 3

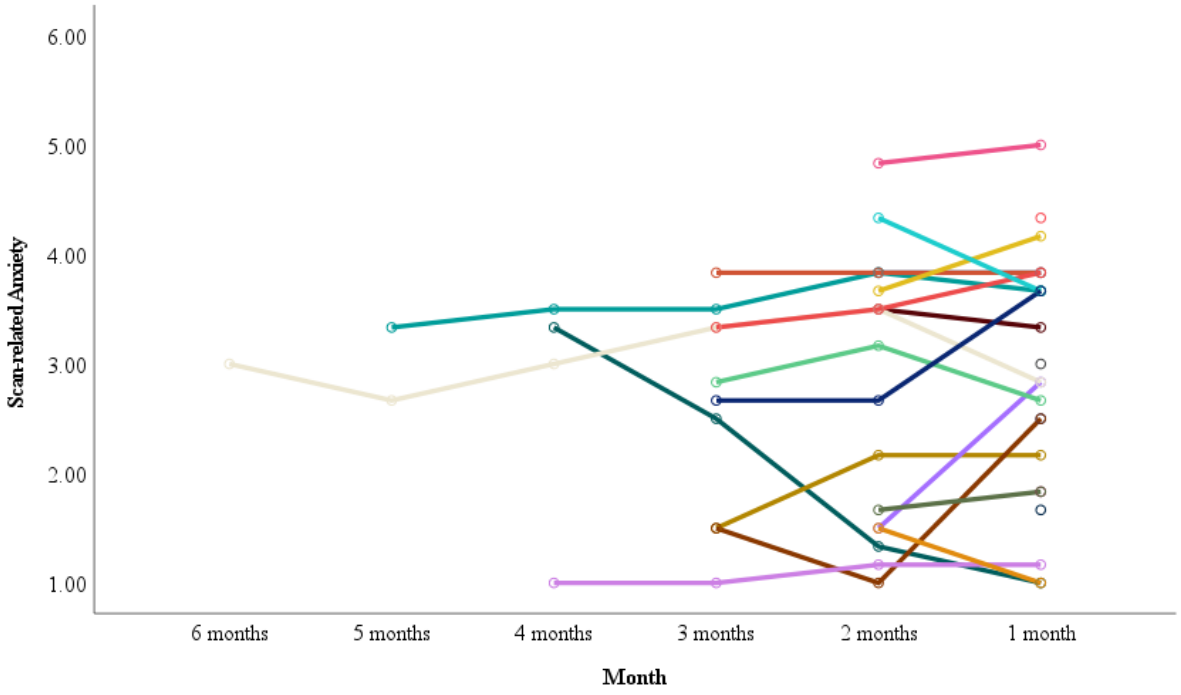
Proactive Coping in the Months Before the Scan – Spaghetti Plot (N = 24)



Note. The average proactive coping for each participant for each month that they received the monthly measures before their scan. The X-axis refers to the number of months before the participants' CT scan. One participant did not receive a monthly measure as they were within a week of their upcoming scan when recruited.

Figure 4

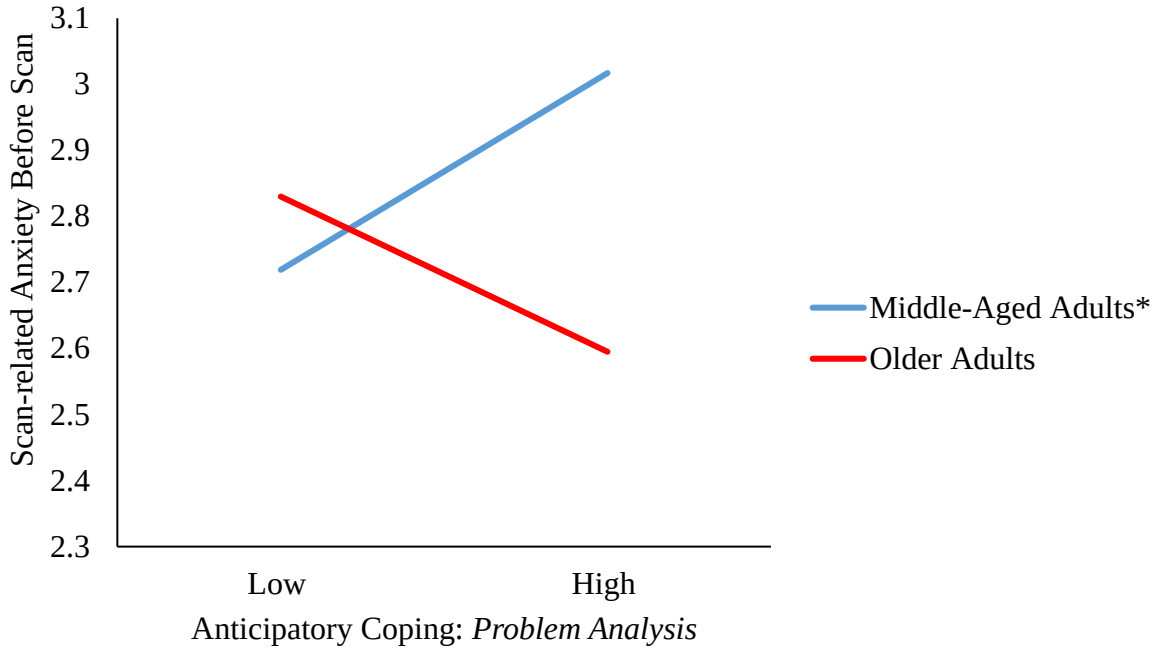
Scan-related Anxiety in the Months Before the Scan – Spaghetti Plot (N = 24)



Note. The average scan-related anxiety for each participant for each month that they received the monthly measures before their scan. The X-axis refers to the number of months before the participants' CT scan. One participant did not receive a monthly measure as they were within a week of their upcoming scan when recruited.

Figure 5

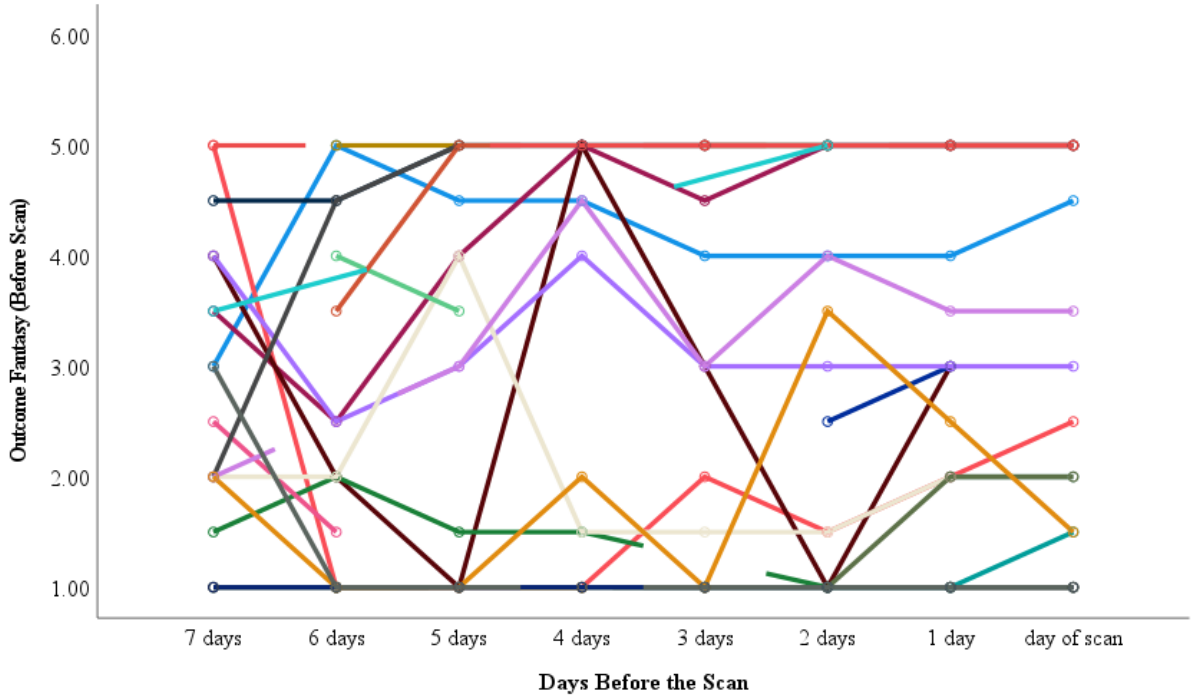
Before Scan Daily Problem Analysis and Scan-related Anxiety as a Function of Age



Note. The slope for middle-aged participants (age 43-62) is significant (.18(.08), p = .027), while the slope for the older participants (age 63-78) is not (-.01(.16), p = .93). *p<.05

Figure 6

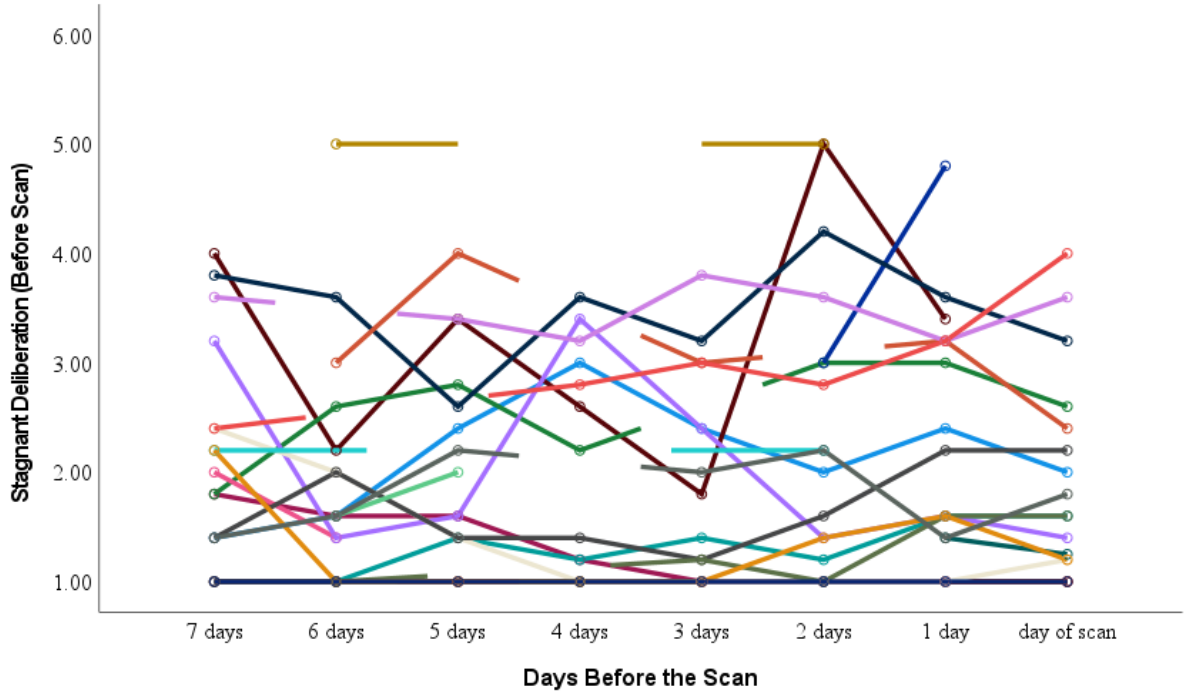
Outcome Fantasy in the Days Before the Scan (N = 25)



Note. The average outcome fantasy for each participant for each day that they responded to the daily measures before their scan.

Figure 7

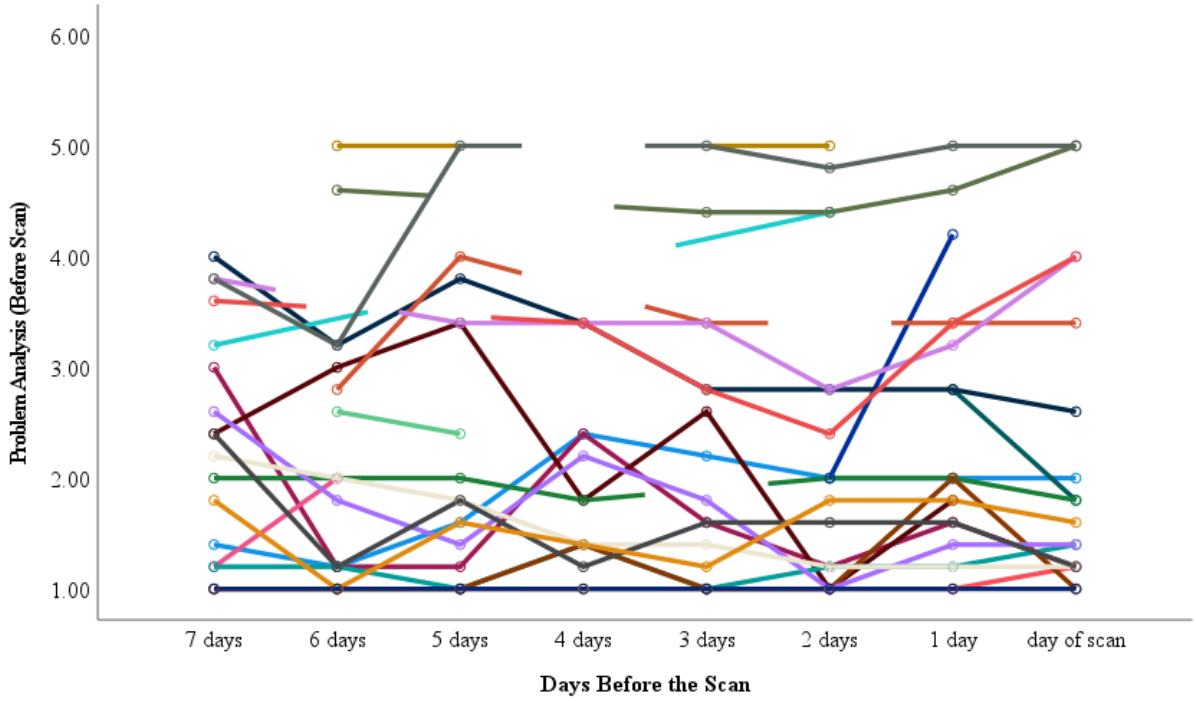
Stagnant Deliberation in the Days Before the Scan (N = 25)



Note. The average stagnant deliberation for each participant for each day that they responded to the daily measures before their scan.

Figure 8

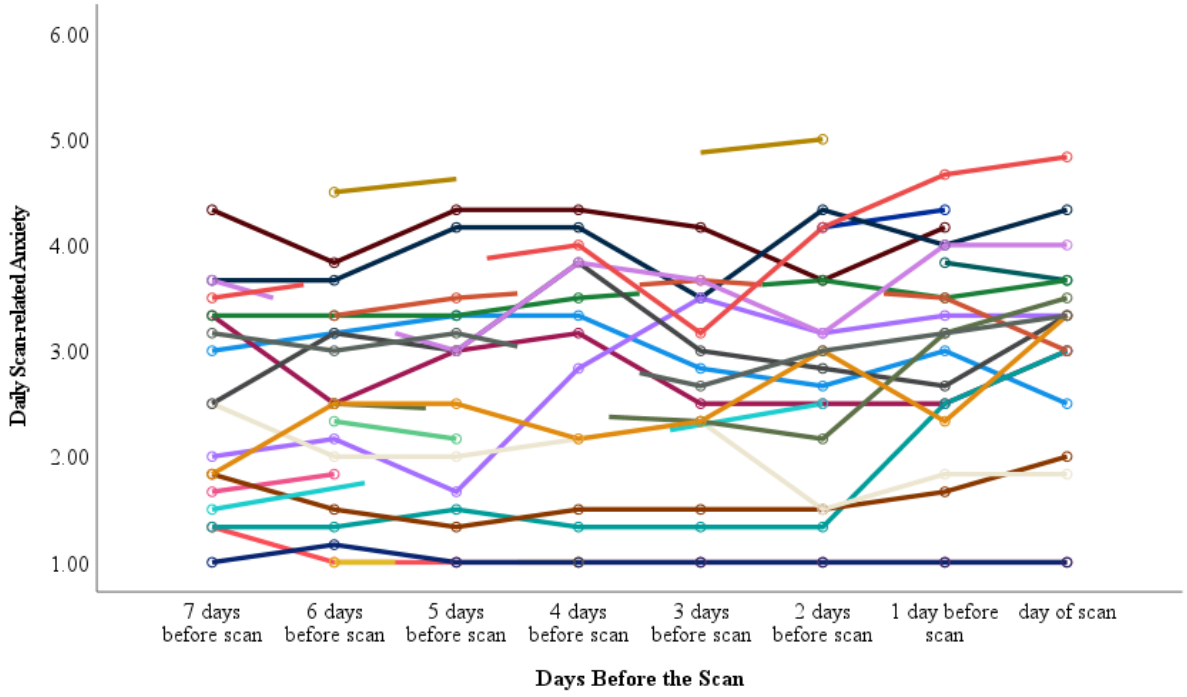
Problem Analysis in the Days Before the Scan (N = 25)



Note. The average problem analysis for each participant for each day that they responded to the daily measures before their scan.

Figure 9

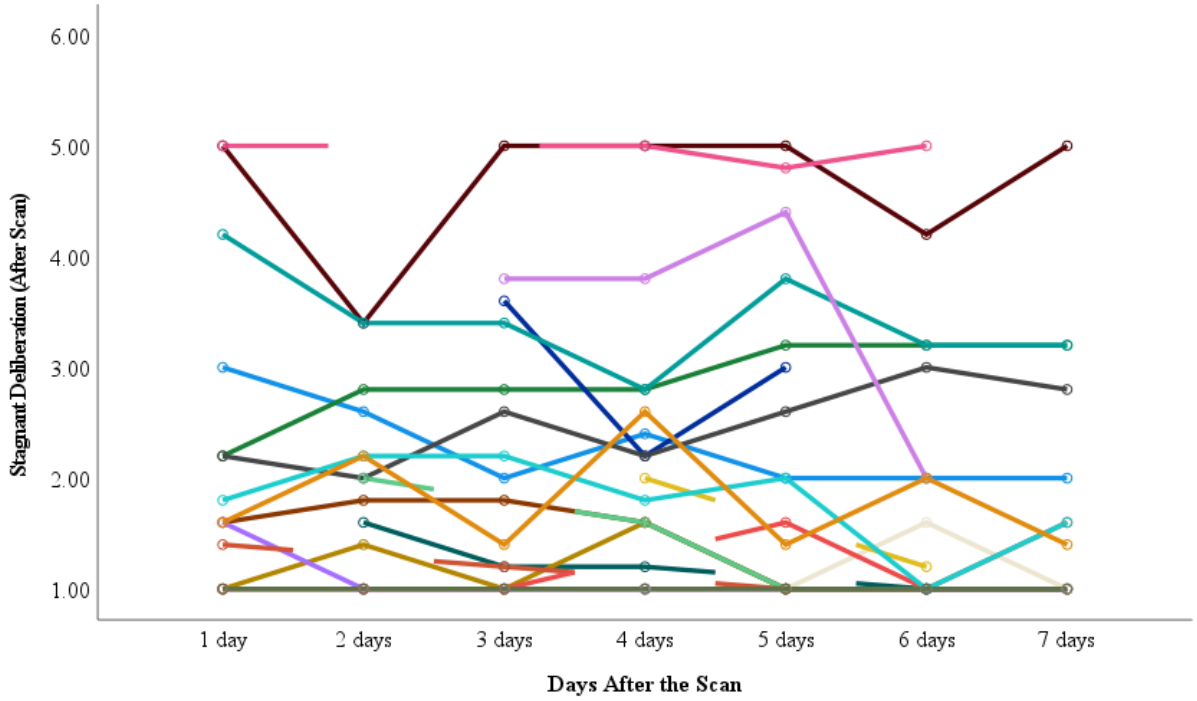
Scan-related Anxiety in the Days Before the Scan – Spaghetti Plot (N = 25)



Note. The average scan-related anxiety for each participant for each day that they responded to the daily measures before their scan.

Figure 10

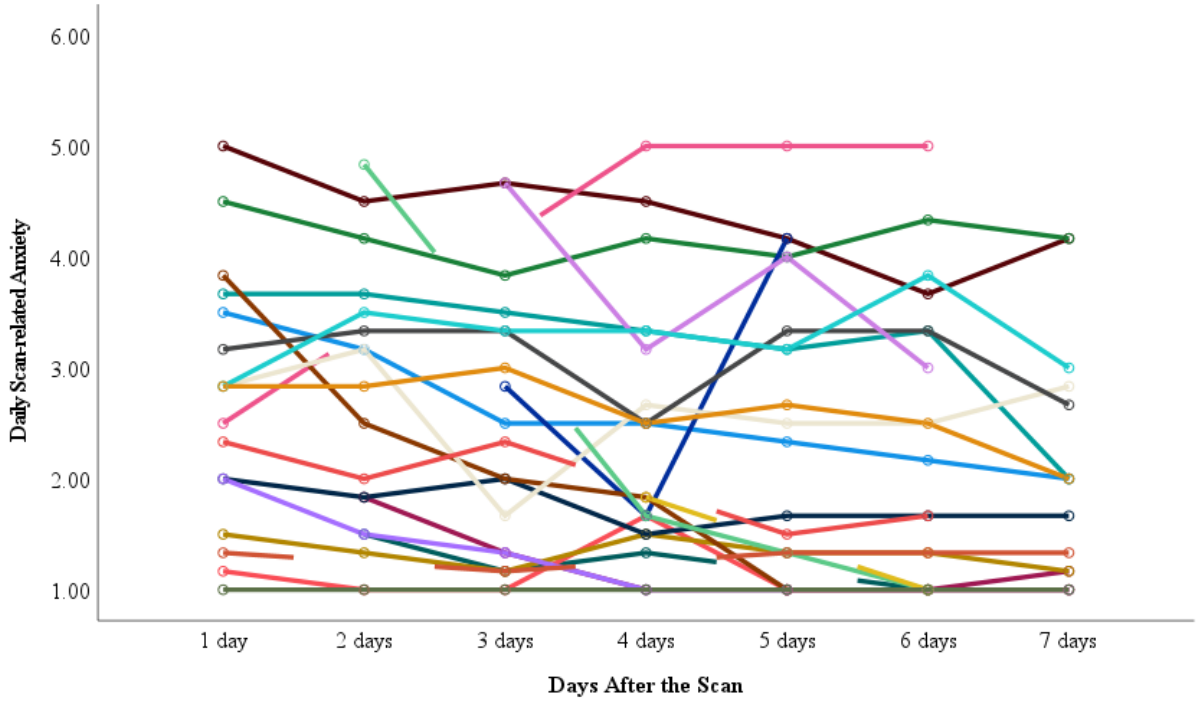
Stagnant Deliberation in the Days After the Scan (N = 23)



Note. The average stagnant deliberation for each participant for each day that they responded to the daily measures after their scan. The X-axis refers to the number of days after the participants' CT scan.

Figure 11

Scan-related Anxiety in the Days After the Scan – Spaghetti Plot (N = 23)



Note. The average scan-related anxiety for each participant for each day that they responded to the daily measures after their scan.

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APPENDICES

Appendix A

Proactive and Anticipatory Coping: Definitions and Examples

	Aspinwall & Taylor, 1997	Real-world Lung Cancer Examples
Proactive Coping	"efforts undertaken in advance of a potentially stressful event to prevent it or to modify its form before it occurs"	Not sure how their scan will turn out, makes plans to take off of work the day after their scan.
Anticipatory Coping	Feldman & Hayes, 2005	Real-world Lung Cancer Examples
Stagnant Deliberation	"to dwell repetitively on a stressful life problem and to experience unproductive thoughts about it"	Only thinking of what the CT scan will tell them about their lung cancer. The "what-ifs", without creating a follow-up plan.
Outcome Fantasy	"tendency to respond to potential problems by daydreaming or fantasizing about desired outcomes, while ignoring details of the problem-solving process"	Imagining that their CT scan results show 'stable' or 'no evidence of disease (NED)'.
Problem Analysis	"active contemplation of the antecedents and meaning of future stressful situations"	Thinking of why they were diagnosed with lung cancer and what this may mean for the remainder of their lives.
Plan Rehearsal	"envisioning the steps or strategies one could use to achieve a desired outcome"	In preparing for the CT scan results, individuals may make a plan for what they will do for the remainder of their day, or how to address the results in any given scenario (i.e., need additional treatment, NED, etc.)

Appendix B

Are you within 6 months of your next CT scan?

Be part of an NIH-funded research project investigating adjustment processes in lung cancer!

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This study consists of an initial survey with brief monthly surveys up to 6 months before your CT scan, then you will receive a short daily survey 7 days before the scan, the day of, and 7 days after your scan. The estimated time to complete each of the monthly and daily surveys is 5 minutes each.

To participate, you must be within 6 months of your next CT scan, are not currently undergoing treatment (e.g., radiation, chemotherapy, etc.), must be at least 18 years old, and are English-speaking. After completion, you can earn up to $75 for your participation. To begin the process you can contact the principal investigators or scan the QR code below.

If you have any questions, please reach out to the principal investigators: Victoria Dunsmore, vdunsmo@ncsu.edu; or Dr. Shevaun Neupert, shevaun_neupert@ncsu.edu, 919-513-7952.

NC State University promotes equal opportunity and prohibits discrimination and harassment based upon one's age, color, disability, gender identity, genetic information, national origin, race, religion, sex (including pregnancy), sexual orientation and veteran status.

Appendix C

Are you fluent in reading/writing/speaking the English language?

- ○ Yes
- ○ No

What is your age?

Would you be willing to provide your email address or phone number for us to send/administer surveys on a monthly and daily basis during the duration of this study?

- ○ Yes
- ○ No

Date of Upcoming CT Scan (*mm/dd/yyyy*)

Treatment & Diagnosis

	Diagnosis
Date of Diagnosis (mm/dd/yyyy)	
Cancer Site	
Most Recent Treatment Received (Surgery, Chemotherapy, Radiation, Hormone, Other: specify)	
Date Treatment Received (mm/dd/yyyy)	
Outcome (e.g., cured, remission, watchful waiting, active, treatment failure)	

Would you like to proceed to the informed consent?

- ○ Yes
- ○ No

Appendix D

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Informed Consent for Participation in Research

Adult Consent Form

Title of Study: Adjustment processes in lung cancer **(eIRB #** 24042)
Principal Investigator(s): Victoria J. Dunsmore, vdunsmo@ncsu.edu; Shevaun D. Neupert, sdneuper@ncsu.edu, 919-513-7952
Funding Source: National Center for Advancing Translational Sciences (NCATS) (Award #: UL1TR002489)

What are some general things you should know about research studies?
You are invited to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, and to stop participating at any time without penalty. The purpose of this research study is to gain a better understanding of psychological adjustment with lung cancer. We will do this using repeated assessments over the course of time before, during, and after your next CT scan.

You are not guaranteed any personal benefits from being in this study. Research studies also may pose risks to those who participate. You may want to participate in this research because you may gain a sense of satisfaction from contributing to research that could inform future interventions in adjustment for lung cancer patients. You may not want to participate in this research because you do not have the time, or this study causes discomfort or stress as a result of answering questions related to your lung cancer diagnosis.

Specific details about the research in which you are invited to participate are contained below. If you do not understand something in this form, please ask the researcher for clarification or more information. A copy of this consent form will be provided to you; we will email you a copy after we have received your consent. If, at any time you have questions about your participation in this research, do not hesitate to contact the researcher(s) named above or the NC State IRB office. The IRB office's contact information is listed in the *What if you have questions about your rights as a research participant?* section of this form.

What is the purpose of this study?
The purpose of the study is to understand the daily and monthly fluctuations in adjustment among lung cancer patients surrounding their scans. The information obtained will help us better understand how adjustment changes across time, to inform future intervention studies in how best to support those approaching an upcoming CT scan.

Am I eligible to be a participant in this study?
There will be approximately 25 participants in this study.

In order to be a participant in this study, you must agree to be in the study, and have been diagnosed with, and treated for, lung cancer with curative intent treatment, are within 6 months of your next scheduled scan, are an English-speaker, are at least 18 years old, and are willing to complete repeated assessments.

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Informed Consent for Participation in Research

You cannot participate in this study if you do not want to be in the study or if you have been diagnosed with moderate to severe cognitive impairment.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to do all of the following:

1. Complete several online initial questionnaires designed to provide us with background information about yourself, including general health status, cancer history and diagnoses, and attitudes towards your health. This will take approximately 10 minutes.
2. Complete online monthly questionnaires designed to assess your attitudes towards your lung cancer diagnosis, your CT scan, and your general health. This will take approximately 5 minutes, once a month until the week before your CT scan (up to 6 months before your scan).
3. Complete online daily questionnaires the week before and after your CT scan, designed to assess your attitudes towards your lung cancer diagnosis, you CT scan, and your general health. This will take approximately 5 minutes a day, for 15 consecutive days. When completing the surveys (if online), you will need to be in a private place when they complete the surveys and should use a private browser in incognito mode.

The total amount of time that you will be participating in this study is estimated to be 2 hours.

Risks and benefits

There are minimal risks associated with participation in this research. The risks to you as a result of this research include discomfort or stress as a result of answering questions related to your lung cancer diagnosis. If you feel any discomfort or stress as a result of participating in the study, please contact the researchers through our contact information listed below or discuss adverse situations with your existing cancer care team.

There are no direct benefits to your participation in the research. Indirect benefits may result, as our research consistently shows significant decreases in negative mood over time in these daily diary designs. You may also feel a sense of satisfaction from contributing to research that could educate future interventions for lung cancer patients.

Right to withdraw your participation

You can stop participating in this study at any time for any reason. To stop your participation, please contact Victoria Dunsmore at vdunsmo@ncsu.edu, or Shevaun D. Neupert at shevaun_neupert@ncsu.edu, 919-513-7952; Department of Psychology, NCSU Campus Box 7650, Raleigh, NC 27695. If you choose to withdraw your consent and to stop participating in this research, you can do so without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, your data will be redacted from the data set, if requested.

Confidentiality, personal privacy, and data management

Trust is the foundation of the participant/researcher relationship. Much of that principle of trust is tied to keeping your information private and in the manner that we have described to you in this form. The information that you share with us will be held in confidence to the fullest extent allowed by law.

Protecting your privacy as related to this research is of utmost importance to us.

How we manage, protect, and share your data are the principal ways that we protect your personal privacy. Data that will be shared with others about you will be de-identified.

> **De-identified**. De-identified data is information that at one time could directly identify you, but that we have recorded this data so that your identity is separated from the data. We will have a master list with your code and real name that we can use to link to your data. While we might be able to link your identity to your data at earlier stages in the research, when the research concludes, there will be no way your real identity will be linked to the data we publish.

Future use of your research data
To help maximize the benefits of your participation in this project, by further contributing to science, and our community, your de-identified information will be stored for future research and may be shared with other people without additional consent from you.

Compensation
For your participation in this study, you will receive $75 after completing any of the monthly assessments and at least 8 out of the possible 15 daily assessments surrounding your scan.

If you withdraw from the study prior to its completion or complete less than 8 daily assessments, you will receive partial compensation ($25).

Sponsorship and Funding
This research is funded through a CTSA grant from NIH's National Center for Advancing Translational Sciences (NCATS). This means that the sponsor is paying the participant compensation costs for completing the research. The researchers do not have a direct financial interest with the sponsor or in the final results of the study. If you would like more information, please ask the researcher(s) listed in the first page of this form about the funding and sponsorship.

What if you have questions about this study?
If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the researcher, Victoria Dunsmore at vdunsmo@ncsu.edu, or Shevaun D. Neupert at shevaun_neupert@ncsu.edu, 919-513-7952; Department of Psychology, NCSU Campus Box 7650.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the NC State IRB (Institutional Review Board) Office. An IRB office helps participants if they have any issues regarding research activities. You can contact the NC State IRB Office via email at irb-director@ncsu.edu or via phone at (919) 515-8754.

Consent To Participate
By signing this consent form electronically, I am affirming that I have read and understand the above information. All of the questions that I had about this research have been answered. I have chosen to participate in this study with the understanding that I may stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I am aware that I may revoke my consent at any time.

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Informed Consent for Participation in Research

☐ **Yes, I consent to participating in this research study**

Name_____

Today's Date _____

☐ **No, I do not consent to participating in this research study.**

Thank you for your consideration.

Appendix E

Monthly & Demographics: ***Demographics link is removed in following monthly surveys.***

Subject: Adjustment Processes in Lung Cancer: ID #___

Hello,

You have consented to participate in the *Adjustment Processes in Lung Cancer* study. Below are the links for the Demographics survey and your first Monthly survey. Before you go to bed, please use the links and complete these at some point today. You will need the ID # I've written in the Subject line to complete these surveys.

Demographics: https://ncsu.qualtrics.com/jfe/form/SV_d6bf5DjA1x8Svrg

Monthly: https://ncsu.qualtrics.com/jfe/form/SV_9vrpRkoGfzLiVTg

You will be sent another monthly survey exactly 30 days after we receive this survey, and your first daily survey will be sent 7 days prior to your CT scan. Attached is a copy of the informed consent form we went over yesterday.

If you have any questions or concerns, please let me know.

ID #

Daily: ***The 'after' or 'before' scan is removed in the emails; The prompt would change depending on if it was the last day or if it was the day of their scan.***

Subject: Adjustment Processes in Lung Cancer: ID #___

Hello,

You have consented to participate in the *Adjustment Processes in Lung Cancer* study. Below is the link for the Daily survey. Before you go to bed, please use the link below and complete this survey at some point today. You will need the ID # I've written in the Subject line to complete these surveys.

Daily(before scan):https://ncsu.qualtrics.com/jfe/form/SV_en6LSewkx07eXVc
Daily(after scan): https://ncsu.qualtrics.com/jfe/form/SV_3vIGAzgArPHyUK2

You will be receiving your daily surveys at 6am every 24 hours. We will indicate when you will receive your last one.

If you have any questions or concerns, please let me know.

ID #

****Day of Scan:** *Please use the link to complete this survey before your scheduled scan today.*

Follow-Up Survey

Subject: Adjustment Processes in Lung Cancer: ID #___

Hello,

You have consented to participate in the *Adjustment Processes in Lung Cancer* study. Below is the link for your final survey, the follow-up survey. Please use the link to complete this survey at some point today before you go to bed. After receiving this survey, we will contact you regarding compensation for your participation.

Follow-up: https://ncsu.qualtrics.com/jfe/form/SV_bI29oaX1Lqfj7Ya

If you have any questions or concerns, please let me know.

ID

Compensation

Subject: Adjustment Processes in Lung Cancer Compensation

Hi___,

Thank you again for participating in our research; I will be sending the $75 VISA gift card via email shortly (you will receive the email within 24 hours). This gift card may be used for online purchases, but if you have any additional questions or concerns, please let me know.

Thank you again, and have a great week!

Best,
Victoria

Appendix F

Baseline Demographics and Monthly

To begin data cleaning, I examined the baseline demographics and monthly response rates and dates for each participant. Since the monthly surveys were distributed every 30 days, I checked to make sure that participants completed them within a few days of being sent. If so, they were left in the analyses. All 25 participants responded to their applicable monthly surveys I the grace period, as well as to their demographic surveys, and therefore, no data point removal was necessary.

Daily

For daily survey collection, only 1 survey per day was valid. Some participants missed a few days and then tried to ‘make them up’ by doing multiple on one day. As these responses were all time stamped, only the first survey was kept in the data, and the rest were removed. This means that some individuals did not have any valid surveys for multiple days. Two participants had either fully completed their surveys or were over halfway through and then notified the researcher that their scan date had been pushed. With one participant we paused data collection and resumed when the date matched where they were in their scan schedule, and kept their previous data points in our analyses since they were around the new scan date. The other participant had fully completed the surveys and volunteered to restart the daily survey process on the week that was valid for their new scan date. The invalid attempts for this participant were removed.

Appendix G

Additional Measures

(Not included in present study but could be considered for future analyses)

Baseline

Education. Individuals are asked to report the highest grade of school or year of college they completed. Response options range from "1 – less than a high school diploma" to "7 – Doctorate or professional degree (e.g., MD, DDS, PhD)."

Racial Background. Participants check all descriptors they feel describe their racial background. These include "African American or Black", "American Indian or Alaska Native", "Asian or Asian American", "Hispanic, Latino/a/x, or Spanish Origin", "Middle Eastern or North African", "Native Hawaiian or Pacific Islander", and "White". Participants can also select "Not listed here or prefer to self-describe" and specify a different option, or "Prefer not to answer". These are derived from the Schusterman guide to equity, diversity, and research (Kaplowitz & Laroche, 2020).

Gender. Participants are asked which of the following best describes them and are prompted to choose only one: "Gender fluid", "Gender queer", "Man", "Agender", "Woman", "Non-binary", or "Prefer not to answer". These are derived from the Schusterman guide to equity and diversity and research (Kaplowitz & Laroche, 2020).

Marital Status. Participants indicate if they are currently married (or in a domestic partnership), separated, divorced, widowed, or single (never married).

Lung cancer stigma. The shortened Lung Cancer Stigma scale (CLCSS-SF; Carter-Harris & Hall, 2014) assesses patient-perceived lung cancer stigma. Participants are asked to imagine how they would feel under the circumstances described, even if they had not actually

experienced that situation. This measure has 3 subscales with items such as “Having lung cancer makes me feel unclean” (e.g., shame and blame subscale), “Some people who know have grown more distant” (e.g. social isolation subscale), and “Others assume that a patient’s lung cancer was caused by smoking, even if he or she never smoked” (e.g. discrimination subscale); all of which are answered on a 1 (strongly disagree) to 4 (strongly agree) Likert scale. Cumulative scores reflect higher reported stigma. This measure is also assessed in the follow-up survey.

Cancer history. A cancer intake form utilized by the Evidenced-Based Cancer Control Programs through NCI (National Cancer Institute, 2017), is used to gather information on cancer history. These items include date of diagnosis and treatment, outcome of treatment, stage, substage, and the TNM staging system. T refers to the size of the tumor and if it has spread to nearby tissue; N refers to the spreading to the lymph nodes; and M describes cancer metastasis (National Cancer Institute, n.d.).

Monthly

Lung Cancer-related Quality of Life. The 44-item Functional Assessment of Cancer Therapy - Lung (FACT-L) measure (Cella et al., 1995) assess lung cancer-related quality of life. Participants are prompted with symptoms that other people with their illness have said are important and are asked to indicate their response reflecting the last 30 days. This measure has 4 subsections of well-being (e.g., Functional (7 items): “I am sleeping well”; Physical (7 items): “I have a lack of energy”; Emotional (6 items): “I feel nervous”; and Social/Family (7 items): “I get support from my friends”), and an ‘Additional Concerns’ section with nine items such as “I am losing weight”. These items are scored on a 0 (Not at all) to 4(Very much) Likert scale. Participants are assigned a monthly mean score for the scale, and higher scores signify higher levels of quality of life within each subsection.

Subjective Age. This is assessed with two items: "What age do you feel most of the time?" (Felt age) and "If you could choose your age, what age would you want to be?" (Ideal age) (Kastenbaum et al., 1972). Participants indicated their response by filling in the appropriate number of years. Discrepancy scores will be created by subtracting subjective age from chronological age with positive scores reflecting how many years younger an individual felt or would like to be.

Coping Efficacy. The shortened 13-item Coping Self-Efficacy scale (Chesney et al., 2006) is used to understand perceived coping efficacy. Participants are asked how confident they are to do the following items when things aren't going well for them, using a Likert scale ranging from 0 (cannot do at all) to 5 (moderately certain can do) up to 10 (certain can do). Six items related to problem-focused coping (e.g., "Break an upsetting problem down into smaller parts"), four items related to stopping unpleasant thoughts (e.g., "Make unpleasant thoughts go away"), and three items related to getting support from friends and family (e.g., "Get friends to help you with the things you need"). Participants are assigned a monthly mean score for the scale, and higher scores signify higher levels of efficacy.

Daily

Daily Affect. The 10-item Positive and Negative Affect Schedule - short form (PANAS-SF; Thompson, 2007) gathers information on daily affect. The PANAS consists of two 5-item mood scales. Positive affect is measured by words such as attentive, alert, and inspired, whereas negative affect is measured by words such as upset, ashamed, and nervous. Participants are asked to indicate the extent to which they felt these emotions in the past 24-hours. Responses are measured on a five-point Likert scale from 1 (never) to 5 (always), such that higher scores

indicate more of the affect. Scores for each item are averaged, and participants receive a daily score for positive and negative affect.

Daily Stressors. A written 7-item version (Neupert & Almeida et al., 2006) of the Daily Inventory of Stressful Events (DISE; Almeida et al., 2002) is used to assess daily stressors. Participants indicated whether or not they had experienced seven types of stressors within the past 24 hours (i.e., using Yes/No responses), these included: disagreements, potential disagreements, stressful events in the workplace/volunteer setting, stressors at home, network stressors, (e.g., stressors occurring to one's family and friends), personal health stressors, (e.g., problems receiving treatment, medication-related issues, and illnesses) and other stressors not previously mentioned. Individuals receive a sum score for total stressors for each day with higher scores indicating more stressors.

Daily Physical Symptoms. A modified version of Larson and Kasimatis' (1991) physical symptom checklist is used to record daily physical symptoms and consists of 28 different symptoms. These items include symptoms such as fatigue, joint pain, cough, and allergies. Participants check a box next to all symptoms that apply to them for the past 24 hours. A daily composite will be created for each day based on the sum of experienced symptoms, with higher scores indicating more reported physical symptoms.

Daily Subjective Age. This is measured with two items: "What age do you feel today?" (Felt age) and "If you could choose your age, what age would you want to be today?" (Ideal age) (Kastenbaum et al., 1972) Participants indicated their response by filling in the appropriate number of years. Daily discrepancy scores will be created by subtracting subjective age from chronological age with positive scores reflecting how many years younger an individual felt or would like to be each day.

Scan results. These are collected in the daily surveys administered after the scan. These items are "Have you received your results?" with a yes/no response, and if they indicated “yes” they move to the question "How did you receive your results?". Here, they can check as many as necessary from phone call, email, text message, appointment with doctor (in-person or online), and MyChart. These responses are not calculated but are recorded to ensure that participants had received their scan results.

Follow-Up

Future Time Perspective. Using the 10-item Future Time Perspective survey (Lang & Carstensen, 2002), I gathered information on future time perspective. Participants are prompted “How true is this of you?” and respond on a Likert scale of 1(Very Untrue) to 7(Very True). Items include “I expect that I will set many new goals in the future.” and “I have the sense that time is running out.” Means scores are calculated with higher scores reflecting more extended time perspective (i.e., more time in life).

Optional items. I ask if participants want to report on the outcomes of their scans. If they indicate “yes” they provide an updated diagnosis and if “no", they proceed to a qualitative item: "Please write any additional information you feel is important to know regarding your scan and/or lung cancer diagnosis". This is an open-ended response question.