Introduction and Background

Suicide is a major public health problem, particularly for specific cultural sub-populations. For example, data from 2013 indicate that suicide is a top 10 leading cause of death in African Americans ages 15-44 (http://1.usa.gov/1bKGgUh) and a top 15 leading cause of death in African American females ages 15-54 (http://1.usa.gov/1bKGgUh). In 2013, there were also 245 deaths by suicide and 1080 attempts among active Service members, at a rate of 18.7%, 23.4%, and 28.9%, for Active Duty (AD), Reserve, and National Guard, respectively (DoD, 2013). There are a number of evidence-based interventions for individuals who have attempted suicide. However, all of these interventions could be optimized to result in better outcomes and to be made more accessible. One potential optimization and very timely enhancement would be the addition of a suicide prevention smartphone mobile application (app) that includes tools known to be effective for preventing suicidal behavior, such as mood monitoring, coping techniques, community resources, and caring messages. Smartphones are becoming increasingly ubiquitous, and adoption of these devices as tools for psychological healthcare is continuing to rise (Bush, Clubb, Aubrecht, & Jackson, 2015; Miloff, Marklund & Carlbring, 2015; SAMSHA, 2015; Ly et al., 2014). A major benefit of smartphones is that client care can be delivered outside of the clinic, and therefore can increase the reach and bolster effects of traditional therapeutic interventions. This is invaluable for treatment of suicidal persons; an effective app can increase people’s efforts to cope, mobilize their social support networks, and access resources by making relevant tools available, portable, easy to engage with, and interesting to use. Unfortunately, to date, feasibility and meaningful use of a suicide prevention app have yet to be determined, although a proof-of-concept study has found that veterans and their behavioral healthcare providers are more likely to access an app than a comparable non-app protocol associated with managing suicidality (Luxton et al., 2011). If such an app is found to be feasible to access and able to provide meaningful guidance, its added-value to a more traditional intervention can then be evaluated.

Fortunately, there are now some suicide prevention apps available that are ready for feasibility testing prior to being evaluated for their effectiveness in terms of reducing suicidal behavior and its correlates. One such app is ReliefLink (RL), which was developed by the Grady Nia Project (GNP) as a free, user-centered mobile health (mhealth) tool, through a competitive grant from the 2013 Suicide Prevention: Continuity of Care and Follow-up App Challenge (SAMHSA). RL then won $50,000, http://news.emory.edu/stories/2013/09/kaslow_relieflink_app/campus.html. RL provides continuity of care and information links to follow-up care for people at risk for suicidal behavior (see Appendix B). It includes an emergency alert for 911 service, appointment reminders, mood rating, GPS-enabled locations of medical/behavioral services nearby, ability to tweet status, and standard coping activities. Designed to leverage community and care team resources, and train users in coping techniques, RL can reach a broader audience at lower cost and is available to clients at all times, resolving the concern that providers may be unavailable during crises or periods of suicidal ideation. RL is currently available for free on the iTunes store, https://itunes.apple.com/us/app/relieflink/id721474553?mt=8.

It is important to first examine the feasibility of using the app with a population that is comfortable with smartphones and apps to ensure that the app can be easily accessed and
navigated. One such population is university employees. This is a population that can give valuable input on apps strengths and recommendations for improvements needed. Thus, our first feasibility project related to this innovative mhealth tool will assess the existing RL app with non-patient university participants to determine if RL meets functional and technical requirements and collects local data reliably.

Once feasibility of RL with non-patients is determined, feasibility for individuals at risk for suicide, such as those who have attempted suicide, must be determined. In a related vein, it is important to ascertain if mhealth tools, such as RL, are feasible to use and helpful to at-risk populations that historically have had more limited education and access to smartphones, are less technology savvy, and are less likely to turn to mhealth tools than the general public. Thus, our second feasibility study will be conducted with women in GNP, namely low-income, African American women who have attempted suicide. These individuals are at increased risk for future suicide attempts and death by suicide; typically report suicidal ideation and its correlates (depressive symptoms, hopelessness, limited reasons for living); and have difficulties regulating their mood, coping with stress, mobilizing their social support network, and accessing necessary resources in the community. In order to address these difficulties, GNP was developed as a comprehensive, culturally relevant, evidence-based program for the target population. GNP is effective in improving the lives of suicidal African American women (Davis et al., 2009). At post-intervention and follow-up, compared to women randomized to treatment as usual, women in GNP exhibit less suicidal ideation and depressive symptoms, feel more hopeful, and are able to cope more effectively with stress (Kaslowski et al., 2010; Taha et al., 2015. One reason for these improvements is that they find their lives to be more meaningful (i.e., higher levels of existential well-being) (Zhang et al., 2013). However, they continue to have problems accessing resources and social support and their coping strategies are not optimal (Taha et al., 2015). Thus they could benefit from access to an app, such as RL, that gives them easy, on-demand, round-the-clock access to tools that promote their health and well-being, such as coping activities, resource locators, and the delivery of caring contacts (Luxton, 2014).

In addition, it is important to begin to gather data related to the potential for app utilization to be associated with positive outcomes. Given evidence of the enhanced value of psychotherapy interventions if they focus on bolstering people’s strengths, rather than reducing symptoms, we are interested in gathering pilot data to see if app utilization is associated with the manifestation of more strengths. Thus, in keeping with a strengths-based model, for example, Wagstaff and Leach (2015) which has been used to study recovery from injury and trauma in athletics and combat but not recovery following a suicide attempt, we will examine if there is a correlation between app utilization and improvements in subjective well-being, resilience, mental toughness, post-traumatic growth, social connectedness, and human capital consumption.

**Specific Aims**
The proposed research has three specific aims. Promising data will support conducting intervention trials to determine the added value of RL to standard, evidence-based care (SC).

**Aim # 1 – Feasibility Study #1 (F1). Determine feasibility and usability of RL with a sample of nonsuicidal individuals comfortable with using smartphones and apps.** It is hypothesized that two weeks after being trained in RL and instructed on which app functions to use, nonsuicidal individuals comfortable with smartphones and apps will demonstrate adherence to
daily mood tracking, assigned coping strategies, and usage of resource location functions, suggesting ease and feasibility of using RL. Input from participants in F1 can guide future improvements to software functionality and features of RL.

**Aim # 2 – Feasibility Study #2 (F2): RL Component.** Determine feasibility and usability of RL with a sample of suicidal individuals with relatively limited comfort using smartphones and apps for healthcare. It is hypothesized that six months after being trained in RL and instructed on which app functions to use, suicidal individuals with limited experience using apps for healthcare will demonstrate increased adherence to daily mood tracking, assigned coping strategies, and usage of resource location functions, suggesting ease and feasibility of using RL with practice. It also is hypothesized that they will report increased acceptance of RL as a technology support for standard treatment. Input from participants in this second study can guide future improvements to software functionality and features of RL, particularly as related to cultural considerations and relevance for reducing suicidal crises and enhancing coping with suicidal thoughts and feelings.

**Aim #3 – Feasibility Study #3 (F3): Strength-Based Component.** As an extension of Feasibility Study #2, we will use a within-subjects longitudinal design to determine if app utilization time is associated with greater accessing of resources and progress in strength-based characteristics. It is hypothesized that app utilization rates will positively correlate with service utilization and improvements in strength-based characteristics.

**Methodology**

**Participants**

Participants for F1 (2-wks) will be non-patients (N=10) recruited from Georgia Tech Research Institute (GTRI). F1 has been submitted to GaTech IRB for approval. F2-3 (6-mos) will then be conducted with patients (N=25) who meet study criteria, and are enrolled in SC through GNP, following suicide attempt/ideation. F2-3 has been submitted to Emory University IRB for approval. Patients (F2-3) without smartphones will be assigned to the study wait list while additional funding/donations for access is sought by Investigators. Wait-listing for this study will not preclude patients receiving SC. Participants (F1-3) will be compensated $30/hr for each 2-hour assessment session. Recruitment and informed consent will follow standard Human Use procedures. Access to smart phones will be assessed during recruitment. Smart phones and service plans will not be provided as part of this study.

For F1, participants will include males and females ages 18-64, who: speak English, have personal access to a functioning iPhone and service plan, and are current employees of GTRI. Approved recruitment flyers about the RL study containing GTRI Investigator contact information, will be posted in common GTRI areas. Interested participants will contact the Investigator using the information provided on the flyer. For F2-3, participants will include African American females ages 18-64, who: are enrolled in the Grady Nia Project, speak English, have sought inpatient and/or outpatient treatment with GHS following a suicide attempt or ideation, and have personal access to a functioning iPhone and service plan. Participants will be excluded if they have significant cognitive impairments (Mini Mental Status Exam-MMSE < 22, Posner et al., 2008), are actively psychotic or have an imminently life-threatening medical/psychiatric condition per evaluation of the Investigator(s) during the screening period (F2-3). Investigators and Research Coordinator (RC) will be contacted about patients meeting study criteria by
GHS providers following established patient referral procedures. If the patient is no longer on site, Investigators/RC will obtain contact information of the patient from their GHS provider, and contact the patient for an initial screening appointment.

There are no invasive procedures and are no potential risks to the therapists for participating except for time. The strategies used are currently used in treating patients with behavioral disorders. Participation requires either a 2wk (F1) or 6-mo (F2-3) commitment of time plus recruitment and debrief time by participants. Data will be collected for research purposes and the data itself may offer no direct benefit to the subjects. It may be difficult for participants to discuss their life events, feelings, worries, or concerns. Since this study will test a new form of tracking, there may be participant discomforts that are not yet known. Participants will be told that they are free to withdraw at any time without penalty and informed of their rights to and limits of confidentiality. Data acquisition will involve the use of forms that permit electronic capture of all data and will be de-identified using a study number and unique identifier including study site, participant number, and date. The study database will be restricted to study staff designated by PI/Co-PI and confidentiality of data collected will be safeguarded by coding of name with ID numbers and electronic passwords. Paper files used to store data will be stored in a locked file cabinet accessible only to research staff. Participant identity will not be revealed in any description or publications resulting from this research. Serious AEs that are unexpected and considered at least possibly related to study methodology will be reported to the affiliated IRBs within 48 hours. Information about contacting investigators 24 hours/day will be provided to participants at consent. Investigators will review reported AEs at regular research meetings. Drs. Kaslow, Dunn, and Crooks will serve as a case panel to review severe and serious adverse events as well as the pattern of adverse events over time. This study does not entail medication or any medical intervention. As a single site, feasibility study we will not establish a Data and Safety Monitoring Board (DSMB).

Materials and Schedule
RL background and usability measures will be conducted for F1-2. Screening and outcome measures are only relevant to F3. Usability will be assessed at 2-wk (F1) and 16-wk intervals (F2). Outcome measures (F3) will be administered at initial session (baseline), and at 4, 8, 12, 16-wk and 6-mo measurement interval.

Background measures. The Demographic Data Questionnaire (Grady Nia Project) will provide demographic information at baseline.

ReliefLink usability. A brief semi-structured interview at 2-wk (F1) and 16-wk (F2) sessions will gather paper diary RL participant task adherence and resource locator usage, and System Usability Scale (SUS) (Brooke, 1986) data.

Screening and outcome measures. MMSE will provide a brief screen for cognitive impairment at baseline. The Columbia Suicide Severity Rating Scale (C-SSRS) Screener (Posner, et al., 2008) will offer a brief assessment of suicidal behavior at each interval (baseline through 6-mos). The following measures will be used to test strength-based characteristics (baseline through 6-mos): Mental Health Continuum Short Form (MHC-SF) (Keyes, 2009), Flourishing Scale (FS) (Diener et al., 2009), Positive-Negative Affect Scale (PANAS) (Watson et al., 1988), Connor Davidson Resilience Inventory (Connor & Davidson, 2003), Grit-S (Duckworth & Quinn, 2009), Life Orientation Test-Revised (Scheier, Carver, & Bridges, 1994), Posttraumatic Growth Inventory (Tedeschi & Calhoun, 1996), R-UCLA Loneliness Scale (Russell et al., 1980), and Effectiveness of Obtaining Resources scale (EOR) (Sullivan et al., 1992).
Procedure
The Investigator/RC will collect basic Demographic Data (F1-2) and administer the C-SSRS Screener and MMSE (F3). Potential participants meeting criteria will be invited for an intake to review and obtain consent. If the individual is deemed medically stable and willing to participate, he/she will either be assessed for baseline immediately following consent or at a later appointment. Participants will then be trained on RL app features and function, and assigned RL daily mood tracking and completion of a minimum of one stress management activity per day, recording usage of these and any geo-location features on a paper diary form (F1-2). Relaxation exercises to choose from on the current version of RL are audio files (i.e., no visuals), and consist of: Guided Meditation, Energizing Breath, Guided Visualization for Relaxation, Progressive Relaxation, Mindfulness Meditation Body Scan, and Mindfulness of Breathing.

Anticipated Results and Innovation
Aims #1/2 will be examined through thematic analyses, descriptive demographic, mood tracking, usage diary, and SUS data (F1-2). Aim #3 will use a within-subjects longitudinal design to determine if app utilization time is associated with greater accessing of resources and progress in strength-based characteristics (F3). It is expected that RL will function as intended across the measurement period, and that the proposed data collection methodology will be executable within the expected interview session length. Acceptance of RL by users is also expected, as evidenced by positive indicators on the SUS, usage of features, and completion of assigned RL activities, as well as comments during semi-structured interview. Our hope is to transition RL, following GNP patient feasibility studies, to a clinical intervention trials with GHS patients. We ultimately hope that as a result of using RL, individuals will benefit by learning new ways of coping with suicidal thoughts/feelings and gaining access to community resources.

Significance of the Project
A key ingredient of suicide prevention is ongoing contact with at-risk clients outside of the clinic encounter. The GHS patient base often has limited ability to travel across the city to seek medical/behavioral health care. Using RL in conjunction with SC will provide mobile prevention tools that can be accessed anywhere through a supporting mobile device. Further, the use of a single app for emergency contacts, affirmations, and activities means that everything is conveniently located in one place, with a unified, streamlined, and easy-to-use interface. In addition, implementing evidence-based mhealth technology into outpatient clinical processes will provide the critical component of on-demand support through crisis intervention services access, coping skills activities, and clinical care coordination that are needed. Following these preliminary RL projects, we would like to enhance design by: (1) conceptualizing new features, such as more expanded safety resources and additional coping activities used within mindfulness training and dialectical behavior therapy; and (2) designing a methodology for uploading RL mobile data securely to providers associated with the individual user for clinical monitoring and two-way communications. These designs then can be developed and tested in future versions of RL with civilians and Service Members as these research opportunities and partnerships emerge.
Appendix A: References


Appendix B: ReliefLink Example

Figure 1. ReliefLink example screen shots.