Cognitive Rehabilitation for Individuals with Parkinson's Disease: Developing and Piloting an External Aids Treatment Program

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Abstract

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Introduction: Cognitive deficits, including executive dysfunction and memory impairment, are common in Parkinson's disease (PD), and can increase difficulty of daily activities. While impairment-based cognitive treatments have been shown to improve scores on formal neuropsychological batteries, little to no research has focused on functional improvement or quality of life in individuals with PD. **Methods:** Three individuals with idiopathic PD underwent an eight-week external aids treatment program to help achieve personalized goals measured by Goal Attainment Scaling (GAS), *t*-score analysis and descriptive measures, including questionnaires and interviews. A case series research design with baseline, post-intervention and 1-month maintenance outcome measures was used to evaluate the research questions. Principles of systematic instruction were implemented to train the use of external aids. **Results:** All three participants improved in the majority of their GAS Lab and Home goals from baseline to

immediately post-training and at a 1-month maintenance assessment. Two participants demonstrated relatively stable goal attainment from post-treatment to the maintenance period; however, one participant demonstrated less stability. All participants also improved in the majority of their descriptive measures at post-treatment and at the one-month maintenance period. **Discussion:** This case series is the first study to examine an external aids treatment program for individuals with cognitive deficits secondary to idiopathic Parkinson's disease. The positive findings from this study suggests that external cueing may facilitate goal achievement in PD. Outcomes were likely influenced by three primary factors: (1) a theoretically motivated focus on external cuing, (2) well-documented, systematic approach to instruction, and (3) the personalization of goals.

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Introduction

Rigidity, tremor, shuffling steps, and stooped posture—these images quickly come to mind when thinking of Parkinson's disease (PD). Affecting nearly 5 million people worldwide, the motor symptoms of this progressive, neurodegenerative disease have been largely emphasized from the time of its discovery, approximately two-hundred years ago. Though the motor symptoms are most visually noticeable, PD encompasses many other non-motor symptoms that can severely restrict individual's abilities and limit their participation in life activities (refer to the International Classification of Functioning, Disability and Health; ICF; World Health Organization [WHO], 2001). The primary focus of this document is cognitive impairment due to PD, which can potentially encompass a broad range of difficulties across the contexts of impairment, activity, and especially participation (WHO, 2001). In prelude to a description of the cognitive symptoms and associated challenges, the motor and autonomic impairments of the disease was reviewed in the context of the ICF framework.

Motor Symptoms of PD

Motor symptoms of PD fall within the context of impairment, and include resting tremor, akinesia (or bradykinesia), rigidity, and postural instability. Though motor symptoms are identified at the impairment level of the ICF, they also greatly impact individuals' abilities and limit participation in life activities.

Resting tremor is the "most common and easily recognized symptom of PD," and presents unilaterally in distal parts of extremities at a frequency between 4-6 Hz (Jankovic, 2008, p. 369). Tremors can occur in the hands, as well as in the lips, chin, jaw and legs, but less often in the neck/head or voice. Its presentation is variable among individuals with PD, at disease onset and throughout disease course (Hughes, Daniel, Blankson, & Lees, 1993; Rajput,

Rozdilsky, & Rajput, 1991). *Rigidity* is the resistance of muscles to passive movement in all directions, and often presents in a cogwheel ("jerky resistance") pattern characterized by alternating muscle tension and relaxation during passive movement. Rigidity is also associated with several postural abnormalities, such as flexed neck and trunk postures, and flexed elbows and knees (Jankovic, 2008). *Bradykinesia,* or slowness of movement, often results in difficulties planning, initiating and executing movements. Activities of daily living are often performed with a slower pace and reduced reaction times (Berardelli, Rothwell, Thompson, & Hallett, 2001; J. A. Cooper, Sagar, Tidswell, & Jordan, 1994; Giovannoni, van Schalkwyk, Fritz, & Lees, 1999). Bradykinesia may also cause loss of spontaneous movements, and arm swing while walking. A masked and unblinking facial affect is also caused by the related issue of *hypokinesia*, or too little movement. *Akinesia,* often used synonymously with bradykinesia and hypokinesia, can also occur through a phenomenon called *freezing of gait*, where individuals with PD lose their ability to move for a brief period of time. This greatly contributes to increased risk of falls, as well as social and clinical consequences. Finally, *postural instability* often presents itself as a reduction of postural reflexes, which also increases chance of falling. This symptom usually develops in the later stages of the disease.

Additional motor symptoms can include processes that affect gait, speech, and swallowing, and can be equally or even more disabling as the four motor symptoms described above. Gait may present as short, shuffling steps, which subsequently reduces mobility and speed. Many individuals with PD will also develop hypokinetic dysarthria characterized by an increased rate of speech, reduced stress, reduced loudness, and so on. The changes to speech are not due to weakness, but rather to a disruption of the basal ganglia system, causing their movements and perception to be scaled down (Demirci, Grill, McShane, & Hallett, 1997).

Interestingly, people with PD can speak loudly and clearly if they focus on producing loud speech. Dysphagia is also common in PD, and may reduce ability to eat safely, as well as interfere with the social participation aspects of eating. Dysphagia in PD is typically caused by an inability to initiate the swallowing reflex, or a timing delay of laryngeal or esophageal movement (Jankovic, 2008). Drooling can also result from a decrease in swallowing function (Bagheri et al., 1999).

As PD progress, the motor symptoms may begin to interfere with daily activities, dramatically reducing quality of life. Pathologically, these motor symptoms are caused by the degeneration of dopaminergic neurons in the substantia nigra of the basal ganglia system. Dopamine is a neurotransmitter that helps regulate and initiate movements. In PD, dopamine production is gradually diminished, resulting in decreased stimulation of the motor cortex. This in turn results in the aforementioned motor symptoms.

Non-motor Symptoms of PD

Unfortunately, the motor symptoms do not encompass all symptoms experienced by people with PD. Non-motor symptoms frequently occur, and are present in up to 88% of patients with PD (Gallagher, Lees, & Schrag, 2010; Martinez-Martin, Rodriguez-Blazquez, Kurtis, & Chaudhuri, 2011). Non-motor symptoms have a detrimental, if not more detrimental, impact on activities, participation, and quality of life (Martinez-Martin et al., 2011). Non-motor symptoms may include, but are not limited to, autonomic disturbances, sensory alterations, sleep dysfunction, neuropsychiatric disturbances, and cognitive impairment (Jankovic, 2008).

Autonomic disturbances are very common in PD, with approximately half of individuals experiencing significant impact to their quality of life from orthostatic hypotension, bladder

dysfunction and constipation (Allcock, Ullyart, Kenny, & Burn, 2004; Magerkurth, Schnitzer, & Braune, 2005; Velseboer, de Haan, Wieling, Goldstein, & de Bie, 2011).

Sensory deficits are not often recognized as clinical features of PD, but they too can significantly impact quality of life. Frequent sensory abnormalities include olfactory dysfunction, pain and paresthesia (Comella & Goetz, 1994; Djaldetti et al., 2004; Lee, Yeo, Kim, & Youm, 2006; Stern et al., 1994; Tinazzi et al., 2006). In fact, Ponsen et al. (2004) et al. found that olfactory dysfunction is correlated with a ten percent increased chance of developing PD. Disturbed sleeping patterns is another common phenomena for many individuals with PD. Approximately one-third of people with PD present with rapid eye movement sleep disorder, consisting of violent dreams and grabbing behaviors potentially dangerous for a partner.

Sleep disturbances, such as insomnia (difficulty falling and staying asleep) can also occur in indiviudals with PD, with prevalence rates greater than 50% (Boeve et al., 2007; Borek, Kohn, & Friedman, 2007; Gjerstad, Wentzel-Larsen, Aarsland, & Larsen, 2007). Another common symptom includes *fatigue,* or exhaustion in the absence of muscle weakness. This often overlooked symptom is reported to be the most debilitating symptom in up to one-third of individuals, and is frequently associated with reduced quality of life (Herlofson & Larsen, 2003).

Neuropsychiatric disturbances are also common in PD, and can contribute greatly to functional disability. Depression occurs in approximately sixty percent of people with PD (D. Aarsland et al., 2007). Another disabling and often overlooked symptom includes anxiety, with up to forty-nine percent of individuals experiencing anxiety symptoms during the course of the disease (D. Aarsland et al., 2007). Similarly, apathy, or a lack of interest or motivation, and visual hallucinations were also frequently reported in the D. Aarsland et al. (2007) study, with prevalence rates of 54% and 45%, respectively. Additionally, individuals with PD can

experience obsessive-compulsive behaviors characterized by repetitive handling of objects, feelings of restlessness (akathisia), or impulsive behaviors such as binge eating and compulsive shopping (Miyasaki, Al Hassan, Lang, & Voon, 2007; Palmiter, 2007). These behaviors have been found to be associated with higher dosages of dopaminergic medications (Evans et al., 2004). Finally, the cognitive symptoms, which are most germane to the proposed study, was expanded below.

Cognition in PD

A common and underappreciated characteristic of the disease that can be more debilitating than the motor and autonomic symptoms is cognitive impairment (Jankovic, 2008). Cognitive deficits, even if "mild," can have a pronounced impact on daily functioning and contribute to caregiver strain, as well as increased hospitalizations and decreased quality of life for individuals with PD (K. Dujardin et al., 2010; Kulisevsky & Pagonabarraga, 2009; Reid, 1992; Troster, Woods, & Morgan, 2007) Zhong, Peppard, Velakoulis, & Evans, 2015).

Terminology

Cognitive deficits in PD can range from discrete, high-level difficulties to a full dementia. In much of the extant literature, the terms mild cognitive impairment (MCI or PD-MCI) and PD dementia (PDD) are used to define these varying levels of cognitive decline. Though diagnosis of MCI included the presence of a change in cognition that was not typical for the individual's age (Litvan et al., 2011b), the definitions and criteria of PD-MCI and PDD were heterogeneous, often based on standardized test scores (D. Aarsland et al., 2010b; Litvan et al., 2011a; Litvan et al., 2012). Furthermore, the definition of MCI/PDD segmented the range of cognitive decline into three discrete categories (normal cognition, PD-MCI, or PDD). Thus, these

diagnostic criteria may not have been sensitive to early cognitive decline, especially in high-functioning individuals (Troster et al., 2007).

In 2013, the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5*; American Psychiatric Association, 2013) generated new criteria to reduce heterogeneity and provide a clearer definition of the cognitive impairment found in multiple neurogenic diseases. Mild cognitive impairment and dementia were replaced with the terms mild neurocognitive disorder (mild NCD) and major neurocognitive disorder (major NCD), respectively. Mild NCD was defined as a modest decline from a previous level of performance in one or more cognitive domains, documented by neuropsychological testing, and supported by 1) the concern of the individual or a knowledgeable informant, or 2) clinician's finding of a moderate cognitive decline (American Psychiatric Association, 2013). Major NCD was defined in similar terms with evidence supporting a significant cognitive decline.

Another difference between the NCDs is that cognitive deficits in major NCD "interfere with independence in everyday activities," whereas the cognitive deficits in mild NCD "do not interfere with capacity for independence in everyday activities; however, greater effort, compensatory strategies, or accommodation may be required" (American Psychiatric Association, 2013). Difficulty functioning in life activities is a new diagnostic factor included by the DSM5, which was not previously accounted for in the previous definitions of PD-MCI (Litvan et al., 2012).

The recent transition in diagnostic terminology has helped medical professionals clarify where on the cognitive continuum their patients are most accurately represented. Because diagnosis no longer solely relies on a specific number on a neuropsychological test, individuals with PD who had exceptionally high cognitive levels prior to onset of cognitive decline was

identified as having mild NCD, even if their scores are "above" the normative mean (Troster et al., 2007). While this new terminology is being slowly implemented, the literature review will necessarily reflect the traditional terms of PD-MCI and PDD when describing the potential cognitive impairment of people with PD.

Frequency and Profile of MCI

Approximately 27% of non-demented patients with PD have MCI, with a range estimated to be 20-40% (Litvan et al., 2011b). In fact, twenty to thirty percent of individuals with PD present with some degree of cognitive impairment at the time of their diagnosis (Silbert & Kaye, 2010). MCI is correlated with several factors including increased age, more severe motor symptoms and disease stage, late onset of disease, presence of depression, lower proportion of dopamine agonist use, and lower educational level (D. Aarsland et al., 2010b; Foltynie, Brayne, Robbins, & Barker, 2004; Mamikonyan et al., 2009; Muslimovic, Post, Speelman, & Schmand, 2005; Pai & Chan, 2001). There is significant heterogeneity in the nature of cognitive impairments found in PD-MCI, with the most common deficits centered on visuospatial skills, memory, and executive functioning/attention (D. Aarsland et al., 2010b; Muslimovic et al., 2005).

Visuospatial abilities. Deficits in *visuospatial abilities* can result in the diminished ability to perceive spatial relationships of objects, increasing the risk of falls and accidents, and is a frequently disrupted cognitive domain in PD (D. Aarsland et al., 2010b; Levin et al., 1991) While visual recognition is preserved in individuals with PD, tasks that require visuospatial analysis and orientation have been found to be the most affected, with a progressive pattern of impairment (greater loss of motor function is associated with greater visuospatial impairment; Boller et al. (1984); (Cummings & Huber, 1992; Girotti et al., 1988; Levin et al., 1991).

Memory. *Memory*, the ability to retain and recall information, is also commonly impacted in PD. For example, in a study of 347 participants with PD-MCI, memory impairment was the most commonly disrupted cognitive domain, with a prevalence rate greater than 50% (D. Aarsland et al., 2010b). Deficits in recognition, recall and prospective memory have also been found to occur in PD, with the degree of deficit linked to more advanced stages of the disease (Whittington, Podd, & Stewart-Williams, 2006). Additionally, verbal and nonverbal memory have found to be affected in PD, independent of medication use (D Aarsland et al., 2009; J. Cooper, Sagar, & Sullivan, 1993).

Executive Functioning. While a range of cognitive impairments can occur in PD-MCI, many consider *executive functioning* deficits to be the hallmark cognitive impairment (D Aarsland et al., 2009; Kudlicka, Clare, & Hindle, 2011; McKinlay, Grace, Dalrymple-Alford, & Roger, 2010; Muslimovic et al., 2005). Executive functioning refers to a variety of adaptive abilities used in service of goal fulfillment. Such behaviors include anticipation, self-regulation, planning, initiation, awareness and the use of feedback and memories of past experiences to make moment-by-moment adjustments (Vlagsma et al., 2016; Ylvisaker, 1998). One of the most central components of executive functioning is *attention,* or the ability to concentrate and focus on a task over time while screening out distractions.

Attention. Several studies have found that individuals with PD have an impaired supervisory attentional system, and consequently show abnormal reliance on cortical executive control for automatic tasks, in addition to the typical non-routine tasks (K Dujardin, Degreef, Rogelet, Defebvre, & Destee, 1999; Redgrave et al., 2010). Thus, individuals with PD are taxing their executive and attentional process for all types of tasks, even automatic, routine tasks such as walking and talking (Dirnberger & Jahanshahi, 2013).

Also impaired in individuals with PD is internal control of attention (Brown & Marsden, 1988; K Dujardin et al., 1999). Internal attentional control occurs in tasks without the aid of external cues to focus participant's attention. When not given cues, participants with PD performed worse on tasks taxing sustained and shifting attention than healthy controls (Cools, Rogers, Barker, & Robbins, 2010). In fact, attentional set shifting has been found to be impaired in all stages of PD-MCI (Owen et al., 1992). Attention is foundational and interrelated to many other cognitive processes, such as memory formulation, and is crucial for independence during activities of daily living (D. Aarsland et al., 2010a; Fuller, Pimentel, & Peregoy, 2012).

High frequency of executive dysfunction. The reported frequency of executive dysfunction in PD varies widely, and is likely influenced by the stage of disease progression and chosen outcome measures. For instance, in a study with over 1,300 participants with PD with multiple recruitment sites, approximately 10%, or 135 people presented with executive functioning impairments (D. Aarsland et al., 2010b). In contrast, 100% of 27 participants with PD-MCI in the Muslimovic et al. (2005) study presented with attention/executive functioning impairments. Deficits in executive functions, which can present early on in the disease course, significantly impact day to day tasks (Elgh et al., 2009; Godefroy et al., 2010; Kudlicka et al., 2011). As the disease progresses and dopaminergic depletion spreads from dorsal putamen to frontal striatum, severity of executive functioning deficits increases, specifically in planning ability and attention (Lewis, Dove, Robbins, Barker, & Owen, 2003; Owen et al., 1992; Pascual-Sedano et al., 2008).

Summary of PD-MCI Profile. Individuals with PD can thus experience impairment across the spectrum of cognitive domains. Overall, it is more common for single-cognitive domains to be impaired than multiple cognitive domains in PD-MCI (D. Aarsland et al., 2010b;

Litvan et al., 2012). When deficits of a single domain occur, it most frequently presents as a nonamnestic, or non-memory, cognitive impairment (e.g. executive functioning). When multiple domains are impacted, deficits most commonly occurred in combination with amnestic impairments (D. Aarsland et al., 2010b; Litvan et al., 2012).

Variables associated with MCI

Degree of cognitive impairment has been shown to be associated with the type and degree of motor symptom presentation. In general, severe motor symptoms are associated with greater and more extensive cognitive impairment (Dirnberger & Jahanshahi, 2013). Additionally, the results of recent meta-analysis of 27 studies, found that individuals who presented with non-tremor dominant motor symptoms (postural instability and/or gait problems) were associated with more severe cognitive impairment, especially in attention and executive functioning (Tremblay, Achim, Macoir, & Monetta, 2013).

PD-MCI has also been found to be highly associated with the development of Parkinson's Disease Dementia (PDD). A longitudinal study conducted by Janvin, Larsen, Aarsland, and Hugdahl (2006) found that 62% of participants with PD-MCI converted to PDD over a 4-year period, compared with 20% of individuals with PD with normal cognition. Similarly, several additional longitudinal studies report that PDD usually develops over a several year period in 20%-60% of individuals with PD, with some prevalence rates reaching as high as 78% (D. Aarsland et al., 2001; Emre et al., 2007; Marder, Tang, Cote, Stern, & Mayeux, 1995; Williams-Gray et al., 2009). Furthermore, the particular subtype of MCI has also been found to be associated with PDD conversion. Approximately 70% of those with a single-domain nonamnestic cognitive deficit converted to PDD, while only 40% of those with an amnestic subtype converted to PDD (Janvin et al., 2006). Though percent of PDD occurrence differed

between the two MCI subtypes, PD-MCI of any type is a risk factor for developing PDD. Interestingly, increased levels of depression were also associated with higher conversion rates from PD-MCI to PDD (Janvin et al., 2006).

Overall, PD is the third most common reason for dementia; people with PD have a six fold increased risk for developing dementia compared to the general population (D. Aarsland et al., 2001). PDD can be extremely disabling, affecting almost every domain of life and dramatically reducing functional independence and quality of living, for both the individual and the caregivers (Levy et al., 2002). As PDD is also associated with issues such as rapid motor decline, shortened survival, greater sensitivity to medication, higher risk of developing psychosis, and frequent transfer to nursing homes, it can consequently be the most disabling and life altering symptom of the disease (Reuter, Mehnert, Sammer, Oechsner, & Engelhardt, 2012).

Current Treatments for Parkinson's Disease

Motor symptoms. Management of the motor symptoms for PD has been well studied. Levodopa, a chemical used to make dopamine (a neurotransmitter in the brain) is the most effective treatment for PD motor symptoms (Olanow & Schapira, 2012). Once it crosses over the blood-brain barrier, levodopa converts to dopamine. Levodopa is routinely combined with carbidopa, which aids in the prevention of levodopa decomposition before it crosses into the brain, allowing for smaller dosages of levodopa. This combination of levodopa-carbidopa is commercially known as Sinemet. Levodopa-carbidopa is considered the gold standard treatment for the motor symptoms of PD, and can greatly improve quality of life (Olanow & Schapira, 2012). Though improvements in tremor, rigidity and bradykinesia can be managed with a strict carbidopa-levodopa regimen, motor symptoms such as severely unintelligible speech due to hypokinetic dysarthria can significantly limit and individual's ability to carry out and participate

in life activities. Although there are no medications for severe speech unintelligibly, one method to effectively manage hypokinetic dysarthria is through speech therapy. For example, a behavioral-based voice therapy, the Lee Silverman Voice Treatment (LSVT), is an evidenced-based treatment found to greatly improve loudness in individuals with PD. Generalized improvements in swallowing and facial affect have been observed as well from LSVT (Dumer, 2014; Fox, Ebersbach, Ramig, & Sapir, 2012; Sapir, Ramig, & Fox, 2011; Spielman, Ramig, Mahler, Halpern, & Gavin, 2007).

Cognitive symptoms. While pharmaceutical treatment and speech-language pathology intervention for the management of motor symptoms is highly effective, there is little effect, if any, on the highly prevalent and disabling cognitive impairments associated with PD (Seppi et al., 2011). The proposed study will introduce a novel, external aids treatment program for individuals with PD with mild cognitive impairment. This external aids therapy will incorporate principles of systematic instruction, such as explicit instruction and linking of steps, errorless learning, sufficient and distributed practice, and spaced retrieval, which have been found to be highly effective evidenced-based methods for populations with cognitive impairment, such as acquired brain injury (Ehlhardt et al., 2008; M. M. Sohlberg & L. S. Turkstra, 2011). This treatment program wasgin to fill the gap in the existing literature in terms of behavioral-based, compensatory therapies for cognitive impairments in PD. Before the proposed study is further elaborated, a review of current cognitive-based interventions for individuals with PD was addressed, as well as instructional strategies that have been successful for other populations with cognitive impairments.

Existing cognitive-based treatments for PD: Impairment focused. A review of the literature revealed that current cognitive-based therapies for people with PD are generally

limited, and diverse in terms of intervention type, delivery model, and focus. All treatments were impairment-based, and focused on either improving overall cognition or one or two specific domains of cognition. Service delivery was also diverse, and interventions were provided via a caregiver, conducted one-on-one or in a group setting with a researcher, or self-administered by the client (Cerasa et al., 2014; Edwards et al., 2013; Farzana et al., 2015; Paris et al., 2011; Pena et al., 2014; Petrelli et al., 2014; Sammer, Reuter, Hullmann, Kaps, & Vaitl, 2006). Additionally, some studies targeted to improve cognition through non-traditional methods and through physical training. The vast majority of studies (and systematic reviews) found that cognitive-based therapies often produced some degree of statistically significant improvements in cognition as measured by standardized neuropsychological exams (Leung et al., 2015). However, it was not always clear to what degree individuals were cognitively impaired, if at all, as descriptions of participants varied widely and were often lacking. Furthermore, many studies contained several limitations and produced virtually no improvements in functional or quality of life outcome measures.

Impairment-based cognitive therapies for PD: Traditional methods. All treatments were impairment-based interventions provided through multiple modalities, including paper-and-pencil exercises, cognitive-based games, "themed-based" activities considered cognitively stimulating, computer-based approaches, and combinations of these therapies (Hindle, Petrelli, Clare, & Kalbe, 2013; Leung et al., 2015). They are considered traditional methods because they targeted underlying cognitive domains through activities that tax the intended cognitive domain.

Paper-and-pencil exercises. Specific treatment protocols for paper- and-pencil exercises were not clearly delineated in the studies; however, the general structure of these exercises included participants writing and/or drawing in response to a cognitive task (e.g. drawing lines

between two alternating shapes to train attention; Costa et al., 2014). Paper-and-pencil activities were found to be largely effective in improving a variety of cognitive domains including theory of mind, visual memory, speed of processing, prospective memory and attention (Costa et al., 2014; Paris et al., 2011; Pena et al., 2014). However, these improvements tended to surface in only select neuropsychological measures, while others were unchanged. For example, in the Paris et al. (2011) study, participants improved on only one of four working memory subtests. Additionally, the participants in the Pena et al. (2014) study showed improvements in several cognitive domains (e.g. theory of mind and speed of processing), but no significant improvements occurred in the broader cognitive domains most commonly affected in Parkinson's disease, including verbal memory and executive functioning. Another challenge is that most studies did not measure changes to functional disability (Pena et al., 2014). Furthermore, degree of cognitive impairment ranged among and within studies. For example, 50% of participants in the Paris et al. (2011) study did not present with any cognitive impairment. While all of these studies were randomized controlled trials, they included relatively few participants in the experimental groups (Costa et al., 2014; Paris et al., 2011).

Cognitive-based games. Games included a variety of activities, including matching games to train memory and categorical thinking, and tasks contrasting shapes of different colors and sizes to train inhibition and selective attention. This approach was also found to be effective in improving cognitive scores on 2/4 executive functioning subtests (Sammer et al., 2006). Interestingly, for the two executive subtests shown to improve, the tasks used in the pre- and post-assessment were very similar to tasks used during treatment, so it is difficult to determine if the participants improved their ability to perform the task or if there were improvements in neurological mechanisms of executive functioning. In a similar study, improvement occurred in

1/4 verbal memory subtests and 1/3 executive functions subtests on formal neuropsychological exams (Petrelli et al., 2014). No improvements were found in attention, visuoconstruction abilities, or quality of life. Depression scores improved in the unstructured treatment group, but not in the structured treatment group or control group (Petrelli et al., 2014). Also noteworthy includes the study's relatively small sample size (approximately 22 people per group), and only 25% of participants in the treatment groups presented with PD-MCI. A one year follow up study showed that both groups (structured and unstructured) improved on two tests of overall cognitive functioning when compared to the control group (Petrelli et al., 2015). Information regarding whether or not the participants with PD-MCI improved in their cognition scores was not included. Rather, the risk of developing PD-MCI was discussed: participants in either treatment group had a 18.2% risk of developing PD-MCI, whereas participants in the control group had a 40% chance of developing MCI. However, those who had PD-MCI at baseline remained as having PD-MCI one-year post treatment in both the control group and the unstructured treatment group. One person in the structured treatment transferred from PD-MCI to non-PD-MCI; however, two participants with non-PD-MCI transferred to PD-MCI within this structured treatment group. The study concluded that some type of cognitive training may reduce the risk of developing PD-MCI one-year post treatment, but reversal of cognitive impairment may be very unlikely, even with treatment, for individuals presenting with PD-MCI at baseline.

Activities considered to be cognitively stimulating. Studies implementing this approach used activities thought to increase cognitive engagement, such as holding a discussion about current affairs, using creativity, or solving Sudoku puzzles (Farzana et al., 2015; Nombela et al., 2011). Again, these studies showed improvements in cognitive functions including overall cognition and improved reaction time as measured by standardized test scores and brain imaging

(Farzana et al., 2015; Nombela et al., 2011). However, sample sizes were relatively small (approximately 10-20 participants per study), and the participants in the Nombela et al. (2011) study were not representative of the Parkinson's population, as they did not present with tremor, dyskinesia or any substantial motor impairment—all of which are hallmark motor symptoms of the disease. Further, the level of cognitive impairment of participants was unclear in this study, making it difficult to judge whether improvements occurred in the presence of impaired cognition. Additionally, these studies did not employ randomization and did not utilize a control group (Farzana et al., 2015; Nombela et al., 2011).

Computer-based therapies. Three studies utilized a computer-based approach. Participants in these studies were given structured tasks of increasing difficulty to train specific cognitive domains (e.g. attention). Therapies included attention processing training, speed of processing training, and executive function training, all of which produced statistically significant improvements in targeted cognitive domains as measured by neurophysiological test scores (Cerasa et al., 2014; Disbrow et al., 2012; Edwards et al., 2013). The number of participants in the studies ranged from 15 to 87, with approximately half of participants assigned to a control group. Though significant changes in mean group scores were reported, improvements in speed of processing had a small-moderate effect size (Edwards et al., 2013). Participants in the Disbrow et al. (2012) experimental group improved their initiation times and sequence completion times, however, this skill did not generalize to other tasks of daily living. And, importantly, the cognitive status of participants was either not specified or appeared to be normal in two of three studies (Disbrow et al., 2012; Edwards et al., 2013). Thus, it is difficult to determine if the treatments would have a similar effect on participants with some degree of cognitive impairment.

Impairment-based cognitive treatments for PD: Non-traditional methods. In addition to cognitive-based therapies, several studies examined the effects of a variety of non-traditional methods such as mindfulness training, music therapy, and physical therapy on cognition. Though the methods were non-traditional, their focus was also to improve individual's underlying cognitive impairment.

Wellness and music therapies. A qualitative study of twelve participants with PD assessing the effect of wellness therapy resulted mainly in improved coping patterns (Fitzpatrick, Simpson, & Smith, 2010). No formal cognitive neuropsychological scores were obtained, and further research in needed to determine if wellness therapy impacts underlying cognitive mechanisms. The impact of music therapy on cognition in PD was also investigated. The training appeared to improve set shifting attention abilities in the participants after only 30 minutes of training (Furukawa, Yoshii, & Tabata, 2012). The researchers purport that active music therapy incorporates elements of set-shifting attentional skills. While there was an experimental control group, there was a low number of participants and no maintenance assessment to see if improvements were maintained long-term.

Physical training effects on cognition. Several studies have examined the effects of exercise on cognitive functioning in PD. For example, participants in a virtual reality gait training program learned to navigate and process multiple stimuli presented simultaneously during treadmill walking. This training increased attentional and visuospatial demands and improved scores on corresponding cognitive tests post training (Mirelman et al., 2011). Additionally, studies implementing several types of exercise, including passive exercise, aerobic exercise, and aerobic mixed with resistance training have suggested that exercise can improve some cognitive domains, specifically executive functioning (Cruise et al., 2011; Ridgel, Kim,

Fickes, Muller, & Alberts, 2011; Tanaka et al., 2009). However, studies to support this evidence had relatively small sample sizes (approximately 20 participants per study), and the cognitive status of participants was also not stated or appeared to be within normal limits.

Combined physical training with cognitive therapy. Cognitive therapy in combination with physical exercise has been shown to improve cognitive domains as measured by neuropsychological tests (Reuter et al., 2012). There has been a variety of combination therapies, including training of balance and cognition using a Nintendo Wii and implementing neuropsychological software training followed by motor rehabilitation, (Pompeu et al., 2012; Sinforiani, Banchieri, Zucchella, Pacchetti, & Sandrini, 2004).

While there has been some variability in the degree of cognitive improvement in smaller studies, a large-scale, randomized study of 240 adults with PD-MCI found that combined physical and cognitive training produced greater improvements in cognitive functioning than just cognitive training alone (Reuter et al., 2012). The cognitive training utilized paper and pencil tasks, computerized tasks, and specific tests (e.g. subtests from the *Behavioral Assessment of Dysexecutive Syndrome*) requiring executive and memory functions; the physical training included games and tasks in which participants were trained to perform dual motor tasks (e.g. walking and bouncing a ball) and visuospatial activities (e.g. navigating though obstacles). Cognition tasks and motor tasks were performed separately. This study also implemented a "Transfer Training" component, which guided participants in how to perform activities of daily living in which they were having difficulty. Thus, this study had 3 groups, matched for number of sessions and number of participants: 1) cognitive training, 2) cognitive training and transfer training, and 3) cognitive training, transfer training and physical training. While all groups benefited, the group with cognitive, transfer training and physical training resulted in the greatest

cognitive improvements as measured by formal neuropsychological tests. Thus, there is growing evidence to support the combination of physical and cognitive exercise in PD in combination with an ecological component.

Conclusions from the cognitive-treatment literature for PD. This review revealed that the current cognitive-based therapies for people with PD are diverse in terms of intervention type and focus. The current treatments designed to improve cognition in people with PD include paper-and-pencil tasks, cognitively stimulating games and activities, computer-based therapies, and non-traditional therapies, such as wellness and music therapy. No studies have been conducted on compensatory approaches, such as external aids, with this population. While most studies found that cognitive domains improved as a result of their treatment, many of the studies had few participants and/or the cognitive status of participants was unknown, making it difficult to determine how the therapy would affect an individual with cognitive impairment. Moreover, outcome measures consisted primarily of neuropsychological performance, with little to no indication of improvement to daily life or personal goals. Given the growing, but limited, evidence of successful cognitive rehabilitation strategies for individuals with PD, we turn to the robust literature on treatment approaches and principles found to be effective with other cognitively-impaired populations.

Consideration of a Compensatory Therapy Approach for PD

Compensatory treatment methods. The current treatments available for individuals with PD and compromised cognition are solely impairment-based. At present, there are no studies of compensatory-based therapies addressing the needs of individuals with PD with compromised cognition. This is in stark contrast to other populations with cognitive impairment, such as acquired brain injury or dementia, that are routinely provided with compensatory

interventions (Ehlhardt et al., 2008; Sohlberg et al., 2007). Reversal of cognitive impairment is unlikely for individuals presenting with PD-MCI, despite impairment-based treatment; thus, compensatory treatments should be implemented (Petrelli et al., 2014). The primary compensatory strategies used to combat cognitive impairment in other populations include metacognitive strategies and the use of external aids (Ehlhardt et al., 2008; M. M. Sohlberg & L. S. Turkstra, 2011). The benefits of compensatory treatments are often seen in the improvement in functional activities rather than the improvement of the underlying cognitive mechanisms measured by scores on standardized tests (M. M. Sohlberg & L. S. Turkstra, 2011).

Metacognitive strategies. Improving an individual's ability to self-monitor thoughts and behaviors is the primary goal of metacognitive therapies. By increasing awareness, clients can "self-regulate their thoughts and actions and monitor their performance during activities" (M. M. Sohlberg & L. S. Turkstra, 2011, p. 189). Substantial evidence has been found for the use of metacognitive strategies in the management of attention, executive functions and memory (Kennedy & Coelho, 2005; Sohlberg, Ehlhardt, & Kennedy, 2005). Additionally, metacognitive strategies can be general or task specific, helping clients complete a wide variety or single tasks, respectively. General strategies can help clients generalize their acquired skills (e.g. better self-regulation) to multiple activities, whereas task specific strategies focus on *how* to complete an activity within a specific context, and are often trained as multi-step procedures using systematic instructional principles reviewed below (M. M. Sohlberg & L. S. Turkstra, 2011). Though considered a compensatory strategy by many, there is debate surrounding whether metacognitive strategies are compensatory, with many studies supporting the case for restorative treatment (Fasotti, Kovacs, Eling, & Brouwer, 2000; von Cramon, Cramon, & Mai, 1991).

Self-regulatory, meta-cognitive therapies may be beneficial for several populations suffering from cognitive impairments, especially in cognitive domains of attention and executive functioning. However, the types of cognitive impairments frequently impacting individuals with PD argue against the sole use of a meta-cognitive approach. For example, participants with PD have been found to perform poorly on tasks that required them to internally cue themselves to sustain or shift their attention (Cools et al., 2010; Spencer, 2007). Internal cuing is essential to a metacognitive approach. Interestingly, a study by Disbrow et al. (2012) found that participants improved their ability to perform a cognitive task (e.g. typing a string of digits from memory) after internal cueing training; however, there was virtually no generalization to functional tasks, with improvements specific only to the trained task. Conversely, when given external cues, participants performed better on sustained and shifting attention tasks and ADLs (Cassimatis, Liu, Fahey, & Bissett, 2016; Cools et al., 2010; Spencer, 2007). Due to the common and underlying cognitive deficit of impaired internal cueing and the evidence for external cueing treatments for individuals with PD, a treatment approach encompassing external forms of cuing is supported.

External aids. Most germane to the proposed study are external aids. External cognitive aids are tools or devices that help people with cognitive deficits perform desired tasks or actions. They can reduce the demands on a person's impaired ability or modify the task to align with the person's abilities (M. M. Sohlberg & L. S. Turkstra, 2011, p. 142). External aids can serve multifunctional purposes and be used for a variety of tasks, or they may serve one specific purpose for a single context (Sohlberg et al., 2007). They also can vary in the complexity of the aid (e.g. smart-phone versus post-it notes), the type of cognitive impairment for which they compensate (e.g. attention versus memory), the population for which they are designed (e.g.

cognitively impaired versus mainstream population), and availability (e.g. commercially available versus original developed tool). There are countless options for external aids due to ongoing advances in technology, and not surprisingly, there is considerable overlap with aids used for memory deficits (Sohlberg & L. S. Turkstra, 2011). For example, external aid options found to be successful for individuals with decreased problem solving included memory notebooks with prescribed task sequences and smartphone applications such as the *Planning and Execution Assistant and Trainer*. There are also several external aids designed for individuals with deficits in specific cognitive domains, including memory, attention, executive functions, and problem solving (Sohlberg & L. S. Turkstra, 2011).

External aid evidence for memory improvement. There is strong support for the use of external aids to support individuals with brain injury. A comprehensive review of 21 studies with 270 participants conducted by Sohlberg et al. (2007) summarized the efficacy of external aid interventions for individuals whose memory impairments significantly disrupted their daily functioning. The studies were diverse in the type of external aid used and included (from most common to least common) written memory notebooks/diary planners, electronic hand-held calendar devices, voice organizers, pagers, mobile phones, and customized task guidance systems. Benefits from external aid therapies included increased independence and performance in general activities of daily living, reduction in repetitive questioning, improved navigation and vocational tasks and, common across all studies, was improved day-to-day functioning. For example, reminders set on participants' mobile devices used to improve prospective memory tasks increased participant's ability to complete targeted activities than when they were not reminded (Fish et al., 2007). The review concluded that training the use of external aids for memory compensation should be a practice guideline for individuals with brain injury. However,

methodologies varied widely among studies, from some participants receiving no training to personalized, long-term treatment. So while external aid treatments can be effective for individuals with cognitive impairments, specifics such as reason for device selection and treatment protocols need further investigation.

External aid evidence for improvement of executive dysfunction. Beyond memory impairment, there is also strong evidence for the use of external aids to support individuals with executive dysfunction. A comprehensive review of 54 studies was conducted by Boelen, Spikman, and Fasotti (2011). The authors examined the efficacy of interventions for executive dysfunction for persons with acquired brain injury, including 20 external compensatory strategy studies. This review demonstrated that participants with executive impairments can benefit from external aids, and that performance in both therapy and daily tasks can be improved considerably when external supports are offered (Boelen et al., 2011).

The majority of studies implemented a single case design approach and utilized a variety of external strategies including, but not limited to, paging systems, checklists, digital reminders via the use of a mobile device, and visual cues during functional tasks. To illustrate, one case series improved individual performance in vocational tasks, with generalized effects and stable gains three months post-intervention by training an alarm system paired with a checklist (Burke, Zencius, Wesolowski, & Doubleday, 1991). This strategy was also supported as an intervention tool for individuals with attentional and decreased initiation deficits by Sohlberg and Mateer (2001). Another device in the systematic review included the *Interactive Task Guidance* system, which guided 4 participants through functional tasks (e.g. janitorial routines) through the use of visual cues on a computer screen; this method produced mixed results (Kirsch, Levine, Lajiness-

O'Neill, & Schnyder, 1992). However, this type of external support was found to be effective for both participants in the LoPresti et al. (2008) case series study.

Though many studies were case series, one large scale randomized control trial with 143 participants with impairments in planning, attention, organization, and memory found that NeuroPage, a portable pager that sends reminders to its users, significantly improved the ability of 121/143 participants to successfully perform self-selected functional activities (Wilson, Emslie, Quirk, & Evans, 2001). Seven weeks post-intervention, improvements were stable without the use of pagers in 54/74 participants. The review concluded that NeuroPage is an effective external aid (Boelen et al., 2011).

*Conclusions from the external aids literature for cognitively impaired populations***.** Though most studies used a small number of participants, the vast body of research supports the use of external aids to improve tasks of daily living in participants with memory and executive dysfunction, with the possibility of generalization to untrained tasks, even in the absence of the external aids.

Training External Aids. External aids will only be effective if the person with cognitive impairment remembers to use them, and uses them correctly. To increase the likelihood of success, the training of the use of external aids (or other behaviors) should be grounded in the theoretically and empirically sound instructional practices. Evidence-based practice guidelines have been synthesized from 51 high-quality research studies evaluating treatment methods used to help participants compensate for neurogenic memory impairments (Ehlhardt et al., 2008). This systematic review included just under 1,000 participants (709 belonging to experimental groups and 280 belonging to control groups) who were heterogeneous in their degree of memory impairment and etiology, including individuals with acquired brain injury, dementia and

schizophrenia. The most effective treatment methods to facilitate acquisition and maintenance of skills included *systematic instructional approaches* (Ehlhardt et al., 2008). Systematic instructional methods emphasize explicit, structured learning in which sequences of steps are planned in advance and build in complexity within the context of sufficient practice and repetition (M. M. Sohlberg & L. S. Turkstra, 2011). The key systematic instructional methods include *method of vanishing cues, errorless learning, spaced retrieval*, and a combination of these methods (Ehlhardt et al., 2008; M. M. Sohlberg & L. S. Turkstra, 2011):

Method of vanishing cues: progressively fewer cues and supports are provided as client improves in accuracy.

Errorless learning: models are provided before a client attempts a response in an effort to eliminate errors during the acquisition phase of learning.

Spaced retrieval: a form of distributed practice that manipulates the time intervals at which recall is elicited. Intervals increase in length.

The majority of studies (41/51) reported favorable outcomes using one of the aforementioned systematic instructional methods, and 16/17 studies (94%) that combined systematic instructional methods reported favorable outcomes (Ehlhardt et al., 2008). These systematic instructional procedures were used to train information targets (e.g. facts, concepts, word lists, face-name associations, etc.), and multistep procedures (e.g. programming electronic aids, using external memory aids, route finding, etc.; Ehlhardt et al., 2008, pp. 14-15). Systematic instructional methods were also found to be more effective than conventional methods such as errorful learning and least-to-most cueing strategies (e.g. clinician provides cues and models following client errors).

In addition to the systematic instructional procedures, the following key training variables were highlighted in the Ehlhardt et al. (2008) review:

Use of stimulus variation: Stimuli should be varied to train multiple exemplars.

Use of strategies to promote more effortful processing: Effortful processing occurs through strategies such as verbal elaboration, visual imagery, prediction-reflection, etc. In the review, 9/12 studies (75%) using these strategies reported positive findings.

Providing sufficient practice: Sessions need to provide adequate repetition, with greater training periods (at least six sessions) found to improve learning outcomes.

Use of task analysis: Complex tasks should be segmented into smaller, simpler steps and chained together from simplest to most complex. Clients should reach a predetermined level of accuracy/independence/mastery before progressing to a more difficult step.

Ecological targets: treatment targets should include skills that clients would use in their own daily lives. Interestingly, only 14/51 studies (27%) implemented ecologically valid tasks, but 100% reported positive findings. This evidence supports training functional tasks in therapy, as the skills obtained was more meaningful and useful to the client. These studies also reported high treatment dosages, and utilized task analysis to train procedures.

These systematic instructional principles were researched and studied in the context of participants with diverse cognitive profiles in effort to improve their ability to manage their memory deficits. While the focus of interventions was to improve memory, the same instructional principles can be applied when training other areas of cognition, such as attention

and executive functioning. For example, long-term studies evaluating the effectiveness of external aid treatments showed that participants with deficits in executive functioning benefited from cuing and direct instruction to train external aids (Boelen et al., 2011). Additionally, a recent study demonstrated that training external aids using systematic instructional principles (e.g. errorless learning, method of vanishing cues) improved participants ability to use their memory aids to complete functional activities (e.g. turn off the stove; Bowman, Lindberg, Hemmingsson, & Bartfai, 2010).

Measuring Cognitive Outcomes

Per the robust literature on acquired brain injury, a wide variety of outcome measures have been used to evaluate treatment effects for participants with acquired brain injury. This diversity is highlighted in the comprehensive reviews of Sohlberg et al. (2007) and Boelen et al. (2011), which include 75 studies and represent hundreds of participants with heterogeneous brain injuries and cognitive impairments. Outcome measures shared between the reviews included performance during trained tasks, neuropsychological tests, questionnaires assessing cognitive performance and well-being, and performance during naturalistic/functional tasks. In both reviews, the most commonly used outcome measures were performance on trained tasks and neuropsychological tests. Less frequently reported were self-report measures, generalization measures, functional impact measures, and Goal Attainment Scaling. Many studies implemented several measures to gain a better picture of treatment effectiveness.

Measurement of treatment effects for individuals with PD. Unlike the large variety of outcome measures reported in the brain injury literature, the vast majority of studies researching cognitive-based therapies for individuals with PD primarily relied on formal neuropsychological outcome measures to assess intervention effectiveness. Two frequently used neuropsychological

assessment tools used extensively with PD is the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA). These measures are used to screen global cognition; however, concerns have been raised on the ability of these tools to detect cognitive impairment and/or dementia in individuals with PD (Burdick et al., 2014; Mamikonyan et al., 2009). Even so, the majority of PD cognitive-based treatment studies continue to employ the MMSE or the MoCA as their primary cognitive pre-assessment measure.

Thus far, outcome measures assessing functional benefits of cognitive therapies on activities of daily living have been limited. Of the four PD studies that included functional/quality of life measures, only two reported some type of improvement as measured by self-reported questionnaires (Farzana et al., 2015; Pena et al., 2014). Additionally, none of the reviewed studies included therapies tailored to the individual's specific goals or functional tasks. This markedly contrasts with evidence that cognitive treatments should be tailored to the person's specific needs, and that outcomes should consider the impact to daily life (Sammer et al., 2006). To address this gap in the current research, measures used in the acquired brain injury literature should be implemented in addition to neuropsychological tests, including participant interviews, quality of life questionnaires, and tools quantifying functional outcomes (such as Goal Attainment Scaling), to objectively evaluate improvements in cognition as well as improvements in daily functioning.

Goal attainment scaling. Objectively measuring progress on personalized goals is the ideal for most clinical and research practices. It is challenging, however, to document change in functional, everyday tasks, as goals are often measured as being 'met' or 'not met,' but do not reflect small improvements toward goal achievement. A commonly used outcome measure in several therapeutic and clinical professions (e.g. physical therapy, geriatrics, mental health, pain

management, and early intervention) is Goal Attainment Scaling (GAS), which is a systematic, objective, and quantifiable method used to define and measure progress of goals that are functional to the client (Kiresuk & Sherman, 1968; Schlosser, 2004). GAS was used as one primary outcome measure in the proposed study.

Writing GAS goals and scales. Following the GAS system, different levels of potential achievement on a goal are predefined using a 5-point scale from -2 to +2, which systematically shows progression of goal attainment. On the 5-point scale, the expected outcome (or target goal) equals 0, while *less than expected* equals -1, *much less than expected* equals -2, and *more than expected*, and *much more than expected* equal +1 and +2, respectively (M. Grant & Ponsford, 2014). To differentiate between levels of goal attainment, each level progressively becomes more challenging in one domain (e.g. faster time completion, higher accuracy, longer task duration, etc.; Bovend'Eerdt, Botell, & Wade, 2009). This system demonstrates that achievement can exceed expectations or be less than expected; most importantly, progress (even if small) is shown. Conversely, deterioration of progress can also be demonstrated using this outcome measure.

Before goals are scaled, specifying the target activity (e.g. behavior), support needed (e.g. external aids), performance criterion (e.g. accuracy), and the amount of treatment time (e.g. number of sessions) is needed to form realistic and achievable goals (Bovend'Eerdt et al., 2009). All scaled levels of achievement, even +2, should have the possibility of being achievable for the client, with a score of 0 being the most realistic and meaningful outcome for a specified amount of treatment (Schlosser, 2004).

Advantages of GAS. Treatment changes are often not captured with formal neuropsychological tests (Schlosser, 2004). Regardless of initial performance, GAS is sensitive

to documenting changes in behavior and potential effectiveness of interventions (Hurn, Kneebone, & Cropley, 2006). Additionally, due to the objective and explicit scaling system used in GAS, goal attainment can be compared across different goals within and across individuals, even when goals and interventions differ considerably (M. Grant & Ponsford, 2014). This is achieved through a formula that converts performance into a T-score. See example formula in Appendix A.

Furthermore, GAS is also a collaborative process between the individual with PD and the clinician, and functional and personally meaningful goals are often selected to be targeted during treatment. Collaborative goal-setting has the potential to increase client motivation, produce better outcomes, and extend treatment gains post-intervention (Wressle, Eeg-Ofsson, Marcusson, & Henriksson, 2002). The goals also help focus treatment, as the client will receive explicit instruction on how to achieve their goals.

Psychometric Properties. Several studies and systematic reviews have concluded that when GAS scales are written systematically, GAS is sensitive to changes between baseline and post-invention performance, and that it is a useful outcome measure in multiple rehabilitation settings and in research (Bovend'Eerdt et al., 2009; Hurn et al., 2006; A. Krasny-Pacini, Evans, Sohlberg, & Chevignard, 2016). However, the degree of its validity and reliability as an outcome measure is primarily dependent on how GAS scales are written and the potential biases of the researcher (A. Krasny-Pacini et al., 2016). See Appendix B for recommended GAS reliability and validity criteria.

Summary of Rationale for Proposed Study

Parkinson's disease is a multifactorial disease that can cause debilitating motor and cognitive symptoms. While there has been a plethora of research regarding compensations for

cognitive deficits in populations with acquired brain injuries, no compensatory therapies have been studied with individuals with PD. Impairment-based therapies have improved participant's performance on cognitive measures, but acquired skills often did not transfer to functional activities. Because metacognitive-compensatory methods rely on internal cueing, an ability frequently impaired in PD, there is a need to provide individuals with PD a compensatory therapy providing external support. Thus, the current study is proposing an individualized, external aids therapy program for participants with PD, focused on improving functional and meaningful life activities that are restricted by cognitive deficits. Outcome measures documenting change in functional, meaningful goals should be implemented to determine intervention effectiveness on everyday activities compromised by debilitating cognitive deficits in PD. Specifically, the following research questions was addressed for each participant with PD:

(1) What is the effect of an 8-week external aids training on personally relevant goals as assessed by pre-treatment and post-treatment indicators of **Goal Attainment Scaling** (primary outcome measure) and **self-reported measures of well-being** (*Parkinson's Disease Questionnaire-8, Beck Depression Inventory II, Behavioral Rating Inventory of Executive Functions-Adult Version, PROMIS v1.0-Applied Cognition-General Concerns-Short Form 6a, PROMIS Item Bank v1.0 –Satisfaction with Participation in Social Roles – Short Form 6a,* and *Compensation Techniques Inventory?*

(2) Will the primary outcome and descriptive measures change at the 1-month maintenance phase compared to pre-treatment and immediately post-treatment levels?

(3) What is the effect of the external aids training program on an untreated personally relevant goal as indicated by GAS?

It is hypothesized that positive treatment effects were demonstrated and maintained for the personalized primary outcome measure of GAS, with notable changes observed in descriptive measures.

Methods

Research Design

A case series research design with baseline, post-intervention and 1-month maintenance outcome measures was used to evaluate the research questions.

Participants

Selection. The study population was a convenience sample of individuals with the diagnosis of idiopathic PD. Recruitment of participants occurred through the University of Washington Speech and Hearing Clinic and local PD support groups. Eligibility for the study was based on the following inclusion criteria: (1) diagnosis of idiopathic PD by neurologist, (2) stable antiparkinson medication regimen, (3) age 50 years or older, (4) self-reported difficulty with activities of daily living due to compromised cognition for at least 6 months, (5) stated motivation to improve current level of daily functioning, and (6) ability to attend treatment and maintenance sessions. Exclusion criteria included: (1) presence of moderate to severe dementia, per *Repeatable Battery Assessment of Neuropsychological Status* (RBANS) score of ≤ 2 standard deviations below the 50^{th} percentile in ≥ 3 cognitive indexes, (2) deep brain stimulation, (3) English not first language, (4) severe or uncontrolled psychiatric disorder, (5) severe depression per *Beck Depression Inventory II* (BDI-II) score ≥ 20 (Beck, 1996), (6) neurologic compromise beyond PD (e.g., stroke, traumatic brain injury), (7) preexisting learning disability, (8) alcohol or drug dependent, (9) currently taking sedatives or tranquilizers, (10) vision or hearing not adequate to permit participation in the study, (11) moderate-severe speech intelligibility

impairment, and (12) currently receiving behavioral therapy related to cognitive functioning. A total of 3 participants were enrolled in the study.

Participant description. Participant characteristics are presented in Table 1 and further elaborated below.

Participant 1: P1 is a 58-year-old male diagnosed with PD 4 years and 3 months prior to the study, with cognitive changes becoming notable 1-year post diagnosis. He is a retired mechanical engineer and lives at home with his spouse. He participated in weekly voice therapy, PD dance classes, church events, support groups, and medical appointments during the course of the study.

Participant 2: P2 is a 60-year-old female, diagnosed with PD 3 years prior to the study, with cognitive changes becoming notable 8-months prior to the study. She is a retired physical therapist, and lives at home with her partner. She participated in several exercise classes and doctor appointments during the course of the study.

Participant 3: P1 is a 68-year-old male diagnosed with PD 3 years prior to the study, with cognitive changes becoming notable 1-year post diagnosis. He is a retired lawyer who lives at home with his spouse. He regularly attended medical appointments during the study, and sporadically attended religious events and PD support groups.

Setting

All components of the study took place in the Motor Speech & Cognitive Disorders Research Lab. The study was approved by the Human Subjects Internal Review Board of the University of Washington. Written informed consent was obtained from each participant prior to the onset of eligibility assessment.

Table 1. Demographic and clinical characteristics of participants.

Variable	Participants		
	P1	**P2**	**P3**
Age	58	60	68
Sex	M	F	M
Race	Caucasian	Caucasian	Caucasian
Education	Ph.D.	M.S.	J.D.
Time since PD diagnosis	4 years, 3 months	5 years	4 years
Primary Motor Symptoms **Unilateral (Left/Right)** **Bilateral**	Tremor Right	Bradykinesia Bilateral	Tremor Right
Current Motor Symptoms **Unilateral (Left/Right)** **Bilateral**	Tremor, bradykinesia, rigidity, diminished speech, micrographia Bilateral	Bradykinesia, rigidity in trunk, fatigue, depression, dry eyes Bilateral	Tremor, bradykinesia, rigidity, disturbed gait, diminished speech, micrographia Bilateral
Primary Affected Cognitive Domain	Attention, Planning	Organization, Memory	Short term memory, attention, planning,
RBANS Total Scale Index Score (percentile)	80/160 (9^{th})	93/160 (32^{nd})	70/160 (2^{nd})
BDI-II	13	6	19
PDQ-8	15.625	12.5	65.625
Medications	Sinemet Azilect Modafinil Rivastigmine	Sinemet Azilect Mirapex Levothyroxine	Sinemet Flavix Sertraline Galantamine Memantine Losartan Levothyroxine Hydrochlorothiazide

**Note: PDQ-8 = Parkinson's Disease Quality of Life Questionnaire-8 (Single Index of functioning and well-being: 0 = no effect of PD; 100 = severe impact), BDI-II = Beck Depression Inventory –II (0-10 = within normal limits; 11-16 = mild mood disturbance), RBANS = Repeatable Battery for the Assessment of Neuropsychological Status.*

Measures

The primary outcome measure was goal attainment assessed by Goal Attainment Scaling. Descriptive measures included participant-reported measures of well-being via questionnaires. The *Repeatable Battery for the Assessment of Neuropsychological Status,* self-reported questionnaires, and an External Aids Needs Assessment were administered to provide descriptive information and to inform inclusion/exclusion criteria. Goal Attainment Scaling was then

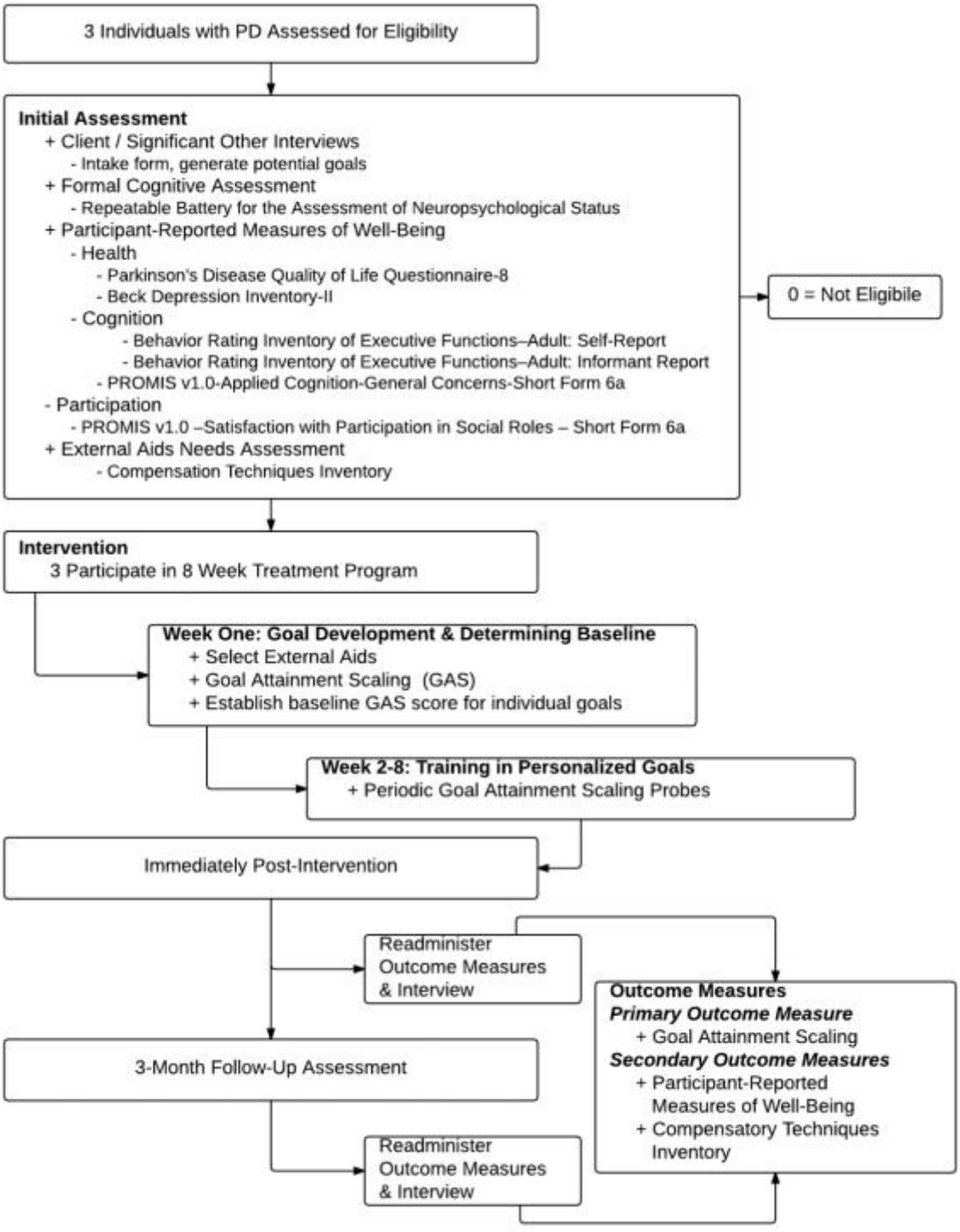
conducted with the three participants following the initial assessment. The data collection measures and procedures are described below and summarized in Figure 1.

Initial Assessment

Each participant received an initial assessment over the course of 1 week that included an interview to determine potential Goal Attainment Scaling scales, a neuropsychological screening, quality of life questionnaires, and an external aids needs assessment.

Client / significant other interviews. Participants underwent a guided interview with their spouse or significant other to address inclusionary and exclusionary criteria, and to characterize their current level of functioning. A pre-determined list of questions (intake form; please see Appendix C) was asked of each participant, and include participants' medication regimen, PD motor symptoms (e.g. laterality, type, time post symptom onset and diagnosis), and cognitive symptoms. Questions also focused on daily routines and activities of daily living, and any challenges participants encountered, ostensibly due to changes to their cognitive functioning. This information served as potential treatment goals. Participants were included in the study if they expressed difficulty with one or more activities of daily living, were concerned about their cognitive functioning, and met all other inclusionary and exclusionary criteria. A similar interview was conducted immediately post-intervention and at the 1-month maintenance assessment to document treatment effects. Interviews were recorded to document descriptive information about treatment impact and participant perspective.

Figure 1. Procedural Overview of Treatment Protocol



Neuropsychological assessments.

Global cognitive status. The *Repeatable Battery for the Assessment of Neuropsychological Status* (RBANS), a neuropsychological screening battery that evaluates

attention, visuospatial abilities, immediate and delayed memory, and language, was administered at baseline to provide a description of the participants' global cognition. The RBANS has been found to be sensitive to neuropsychological deficits in PD (Beatty et al., 2003; Yang, Garrett-Mayer, Schneider, Gollomp, & Tilley, 2009). A summary of the participants' neuropsychological status is shown in Table 1.

Self-reported measures of well-being: Health, cognition and social participation.

Health. Participants' perspectives about their general physical and mental health was evaluated through the following self-reported questionnaires: *Parkinson's Disease Questionnaire—8* (PDQ-8) and the *Beck Depression Inventory*-II (BDI-II). The PDQ-8 assesses the impact of PD through eight dimensions of functioning and well-being, including mobility, activities of daily living, emotional well-being, stigma, cognition, communication, and bodily discomfort (Jenkinson, Fitzpatrick, Peto, Greenhall, & Hyman, 1997). The BDI-II was found to be sensitive to depression for individuals with PD, and was used to rule severe depression (Beck, 1996; Visser, Leentjens, Marinus, Stiggelbout, & van Hilten, 2006). Each questionnaire was re-administered immediately following treatment and at the 1-month maintenance to document treatment effects on participants' perceptions of overall health.

Cognition. To further supplement the description of the participant's cognitive abilities, the *Behavioral Rating Inventory of Executive Functions-Adult: Self-Report (*BRIEF-S), the *BRIEF-Adult: Informant Report* (BRIEF-A:I; Roth, 2005) and the *PROMIS Item Bank v2.0: Applied Cognition—General Concerns—Short Form 6a* were administered. The BRIEF-A, a 75-item, self-report questionnaire, measures aspects of executive function in daily life. These aspects relate to the domains of inhibition, self-monitoring, planning/organizing, shifting, initiation, task monitoring, emotional control, working memory, and organization. Scores from

the BRIEF-S and BRIEF-I were compared to identify areas of agreement and discrepancy between the participants and their significant other. The PROMIS Item Bank contains 6 scaled questions related to participants' perceptions of their general cognitive abilities and related concerns. All measures were re-administered immediately following treatment and at the 1-month maintenance to document treatment effects.

Social Participation. The *PROMIS Item Bank v1.0 –Satisfaction with Participation in Social Roles – Short Form 6a.* was administered to assess participants' satisfaction and confidence in completing social roles and activities. This questionnaire was re-administered immediately following treatment and at the 1-month maintenance assessment.

External aids needs assessment. Participants also completed an External Aids Needs Assessment, which included the *Compensation Techniques Inventory* (CTI), designed to identify the external aid most suited to a particular individual (Sohlberg & Mateer, 2001; M. M. Sohlberg & L. S. Turkstra, 2011). Please refer to Appendix D to view the CTI.

The CTI collected information about daily activities impacted by cognitive changes, and past and current successes and challenges with external tools (M. M. Sohlberg & L. S. Turkstra, 2011). Information gathered from the CTI, combined with data collected from the initial interview and neuropsychological testing, was used to identify the external aids that each participant used to obtain their goals. Participants' goals, aid preference, familiarity, and past successes with external aid(s), were strongly considered when selecting external aids. The process was collaborative, with the selected external aids having the greatest estimated potential to influence everyday functioning as desired by each participant.

Procedures

Participants engaged in therapy sessions for 8 weeks with 2 weekly, 1-hour sessions. The first 1-2 sessions focused on goal development, which included selecting external aids and defining goals using Goal Attainment Scaling (GAS). The remaining sessions included external aid training to target each participants' individual goals. Each participant received therapy in each of their goals defined by their GAS scales (3-6 goals each). An additional task (logic puzzle) was not treated, and served as a control goal to document experimental control.

Goal development. The first 1-2 sessions included Goal Development, which involved interpretation of the External Aids Needs Assessment, selection of appropriate external aid(s), defining goals using Goal Attainment Scaling (GAS) through a collaborative interview, and determining baseline performance.

Goal attainment scaling. GAS was used as the primary outcome measure for this study. Through motivational interviewing, participants collaborated with the investigator to write personalized goals using GAS, which is an objective method for measuring progress toward functional goals (Miller, 1991; Schlosser, 2004). Following the GAS system, different levels of potential achievement for a goal were predefined using a 5-point scale from -2 to +2, which systematically indicated progression of goal attainment. On the 5-point scale, the expected outcome (or target goal) equaled 0, while *less than expected* equaled -1, *much less than expected* equaled -2, and *more than expected*, and *much more than expected* equaled +1 and +2, respectively (M. Grant & Ponsford, 2014). To differentiate between levels of goal attainment, each level progressively became more challenging in one domain (e.g. faster time completion, higher accuracy, longer task duration, etc.; Bovend'Eerdt et al., 2009). All scaled levels of achievement, even +2, had the possibility of being achievable for the client, with a score of 0 being the most realistic outcome for the specified amount of treatment (Schlosser, 2004). Each

GAS scale was reviewed by at least one additional investigator to verify that each level on the scale was equidistant, non-overlapping, and that goals are "SMART": specific, measurable, achievable, realistic, and defined in time (Bovend'Eerdt et al., 2009; A. Krasny-Pacini et al., 2016; A. Krasny-Pacini, Hiebel, Pauly, Godon, & Chevignard, 2013). Refer to Appendix C to view an example of motivational interview questions used to define collaborative GAS goals.

All GAS goals were pre-defined, meaning they were written prior to the baseline assessment. Baseline performance was verified during baseline probes. If a participant demonstrated achievement at a level of -1 or 0 on their predefined GAS scale, the GAS scale was revised (when possible) to ensure that the participant's initial baseline performance was equivalent to a -2 (*much less than expected)* to maintain consistency and directly compare goal attainment between and across participants. If a participant demonstrates achievement at a level of +1 or +2 the goal was considered met and was not targeted in treatment (A. Krasny-Pacini et al., 2016; Agata Krasny-Pacini et al., 2014). Goal attainment was measured at baseline, periodically during the treatment phase, immediately following treatment, and 1-month post-intervention.

Before GAS goals were written, the participants and the investigator defined all goal elements: (1) participant's external aids, (2) the specific activity or activities in which the external aids were used, (3) the specific target behavior the participant desired to achieve, (4) a reasonable level of achievement (criterion), (5) the duration of therapy in which to achieve these goals, and (6) the level of importance and difficulty of each goal (Bovend'Eerdt et al., 2009). Once all goal elements were identified, goals were written using the GAS system described above. Each participant identified 3-6 goals related to daily activities using their external aid(s).

Refer to Appendix E to view one process of writing GAS goals as described by Bovend'Eerdt et al. (2009), and Appendix F and Tables 4A-B, 5, and 8A-J for the participants' GAS scales.

Furthermore, each GAS goal was written as two goals when possible: (1) a directly observable goal within the laboratory that the participant agreed was indicative of meaningful progress, and (2) an indirectly observable goal (that closely paralleled the laboratory goal) that was measured by the participant's significant other or the participant him- or herself in the participant's home/community. All significant others and participants (when necessary) received instruction on how to document each participant's home/community goals in attempt to establish objectivity and reliability in documenting functional goals.

Training external aids. Training external aids inherently incorporates multistep routines (e.g. a series of steps to navigate an electronic calendar to make an entry). Thus each goal was trained using systematic instructional principles discussed previously (Ehlhardt et al., 2008). The following principles of systematic instruction were implemented:

Errorless Learning: models are provided before a client attempts a response in an effort to eliminate errors during the acquisition phase of learning.

Use of task analysis: complex tasks was segmented into smaller, simpler steps and chained together from simplest to most complex.

Spaced Retrieval: a form of distributed practice that manipulates the time intervals at which recall is elicited. Intervals increase in length.

Method of Vanishing Cues: progressively fewer cues and supports are provided as client improves in accuracy.

Providing sufficient practice: sessions need to provide adequate repetition, with greater training periods (at least six sessions) found to improve learning outcomes.

Use of strategies to promote more effortful processing: Effortful processing occurs through strategies such as verbal elaboration, visual imagery, prediction-reflection, etc.

Use of stimulus variation: Stimuli was varied to train multiple exemplars.

Ecological Targets: treatment targets will include skills that clients would use in their own daily lives.

Furthermore, two interwoven steps were implemented when teaching external aids: (1) teaching the participant *how* to use the aid(s) and (2) teaching the participant to use the aid in a more consistent and fluid manner *within* a specific activity/goal (M. M. Sohlberg & L. S. Turkstra, 2011). External aids were trained within the context of simulated situations within the laboratory that aligned with functional goals; however, each participant needed some degree of training in learning the mechanics of their external aid (e.g., opening to the right cellphone application, troubleshooting when an incorrect selection was made, etc.). Errorless learning was used consistently to diminish errors and establish correct sequencing when using tools. Once participants demonstrated independence in one step of the procedure, they received instruction in the following steps until they demonstrated independence in the entire sequence. Refer to Appendix G for an overview of the training sequence and an example of teaching multistep procedures using an external aid. As the participants gained more training in their external aids within functional tasks (e.g., scheduling appointments on the iPhone via voice command), fluidity and consistency in external aid use was targeted.

Personalized goals were targeted in a sequential manner, with one goal being the primary focus of treatment until achieved at the expected outcome level; the next goal was then targeted. Once a participant had 2-3 training sessions in a goal, the goal was probed to document potential change in goal achievement. Following the probe, additional training in a goal was provided if deemed necessary (e.g., participant achieved a -2 or -1 during a probe). Periodic probes of trained goals occurred during the 8-week treatment period to document achievement level and maintenance throughout the treatment phase. Following a probe, participants were told how they were progressing and where they were in relation to achieving their GAS goals.

Data collection and analysis. All outcome measures, with the exception of the RBANS, were administered at baseline, immediately post-intervention, and at the 1-month maintenance assessment. The RBANS was only administered at baseline to describe the participant's global cognition. Additionally, an interview was used to ascertain the participant's and significant others' perspectives about the treatment process. GAS was used as the primary outcome measure to document meaningful change in relation to the participants' goals.

GAS: Data collection. Level of achievement on GAS goals (from -2 to +2) was measured at baseline, throughout treatment (following 2-3 sessions of training per goal), immediately-post intervention, and at the 1-month maintenance. Periodic measurements of GAS goals throughout treatment were used to monitor meaningful change in goal achievement for the participants' goals. Furthermore, GAS was measured through two sources: (1) indirectly via significant other's report and (2) directly observed within the laboratory. These two data sources allowed for comparison of the level of achievement between settings.

Indirectly observable / home-goals. Home Goals captured daily events that the study's investigators could not directly observe. However, this type of measure was essential to the

study's purpose: to capture functional change as it related the participants' lives. The participants' spouses were asked to collect data for all goals at baseline, immediately-post treatment, and at the one-month maintenance assessment. They were also asked to take data during the treatment phase for all goals. P2 and P3 completed this data collection process as intended. P1's significant other was not able to provide data for P1's Home Goals 1 and 2 during any phase of the study; however, the investigator collected data for these Home Goals on the first session of each week from week 4 to week 8, and at the two assessment periods (immediately-post-treatment and at the 1-month maintenance). P1's significant other was, however, able to provide data for Home Goal 3 from week 4 onward, and for both post-treatment assessments. Two research assistants independently interpreted Home Goal data, and assigned a GAS score for each Home Goal.

Directly observable / laboratory-goals. The same two research assistants also independently measured each participant's goal achievement on their respective Laboratory Goals at baseline, during treatment, immediately-post treatment and at the 1-month maintenance assessment. Any dispute over level of goal attainment was resolved though discussion and video observation until a level of achievement was agreed upon. These lab goals were closely related simulations of the *home goals*, intended to capture meaningful changes that were directly observable.

GAS: Data analysis. To provide a more objective means of interpreting Goal Attainment Scores, participants' goal attainment at baseline, immediately post-intervention, and at the 1-month maintenance assessment was examined using the following aggregate formula:

$$\mathrm{GAS} = 50 + \frac{10\Sigma(w_i x_i)}{\sqrt{((1-\rho)\Sigma w_i^2 + \rho(\Sigma w_i)^2)}}$$

where w_i equaled the weight of each goal (importance X difficulty)[1], x_i equaled goal attainment (-2 to +2), and where p equaled the expected correlation of goal scales (0.3; Kiresuk & Sherman, 1968). Though no formal or specific methodology has been developed to interpret GAS scores, an "expected outcome" range for this study was determined to include T-scores from 40-60 (One standard deviation from the mean T-score of 50) as recommended by Grant et al. (2012).

Each participants' GAS scores from their Lab Goals and Home Goals were converted into a single T-score using the aforementioned formula. For example, P1's three Lab Goals were analyzed collectively at post-treatment and maintenance to document goal attainment at different assessment points in the study. Additionally, goals from all participants with a baseline score of -2 were collectively analyzed to document the "group's" goal attainment between baseline, post-intervention and at the 1-month maintenance assessment.

Results

Participant One

Initial Assessment. P1 presented with moderately impaired attention and executive functions, especially in planning and organization, as determined by the baseline interview, self-reported questionnaires, and formal testing via the RBANS. His reported planning and organization deficits were causing him to be consistently late to appointments. For example, if an event started at 4:00pm, he would start his shower at 3:50pm. P1's spouse routinely compensated by telling P1 that events started an hour earlier than scheduled. P1's spouse scheduled all of his appointments, and they used a central wall calendar and individual pocket calendars to

[1] Importance = 1 (a little important), 2 (moderately important), or 3 (very important).
Difficulty = 1 (a little difficult), 2 (moderately difficult), or 3 (very difficult).
GAS literature reports several ways to weight goals, and none of the current methods are recognized as being the most efficient weighting practice (Bovend'Eerdt et al., 2009; M. Grant & Ponsford, 2014; Michele Grant, Ponsford, & Bennett, 2012; Turner-Stokes, 2009). In this study, the participant will determine the importance and difficulty of the goals.

coordinate schedules. P1 had an iPhone and used this primarily for texting and calling. He also used post-it notes to facilitate recall.

Goals. The primary focus of P1's therapy was to increase his independence in arriving to appointments on time. To help achieve this goal, three co-constructed goals were developed, including (1) scheduling appointments using his iPhone, (2) planning for appointments by setting appropriate alarms, and determining travel times and planning activities (all within his cellphone calendar application) and (3) being prepared and on time for events. Each of these goals were written as Home Goals and Lab Goals (see Tables 2A and 2B).

Description of external aid selection. Prior to the selection of his cellphone calendar application to manage his schedule, P1 was provided a paper calendar with 15-minute time slots to schedule his appointments. This external aid was selected because it was familiar to both P1 and his spouse, and the spouse was initially resistant to cellphone applications. However, this external aid was determined to be impractical at week 2 of the study due to P1's poor legibility, and a computer calendar in which P1 typed calendar entries was then trialed. Though P1 demonstrated the ability to schedule appointments with this method with improved legibility, it was time consuming and laborious. Thus, his cellphone calendar application using voice command to schedule appointments was trialed and determined to be the most effective and efficient external aid to schedule appointments. He was introduced to the cellphone application at week 4 and continued to use this external aid throughout the study. For each external aid trialed, P1 received systematic instruction to learn the tool's procedures (per (Ehlhardt et al., 2008).

Table 2A. Lab Goals for P1 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Goal 1: Scheduling—Lab Goal				
-2	**-1**	**0**	**+1**	**+2**
Given a list of 8 events to schedule for a given week:				
*P1 will accurately transfer 0-1 appointments to a weekly calendar.	P1 will accurately transfer 2-3 appointments to a weekly calendar.	P1 will accurately transfer 4-5 appointments to a weekly calendar.	P1 will accurately transfer 6-7 appointments to a weekly calendar.	P1 will accurately transfer 8 appointments to a weekly calendar. **ACHIEVED^{P,M}**
Goal 2: Planning—Lab Goal				
Given a list of 8 events to schedule for a given week:				
*In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 0-1 appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 2-3 appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 4-5 of appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 6-7 of appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 8 of appointments for 1 week. **ACHIEVED^{P,M}**
Goal 3: Arriving on Time—Lab Goal				
When given 30 minutes (for preparation of 2 events + action; triggered by cell phone alarm)				
*P1 will arrive lacking preparedness AND timeliness for both events.	P1 will arrive lacking preparedness OR timeliness for both events.	P1 will arrive prepared and on time for one event, but lacking preparedness AND timeliness for the second event.	P1 will arrive prepared and on time for one event, BUT lacking either preparedness or timeliness for the second event.	P1 will arrive prepared and on time for both (2) events. **ACHIEVED^{P,M}**

* = Baseline Score, ^{P} = Post-treatment, ^{M} = Maintenance

Table 2B. Home Goals for P1 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Goal 1: Scheduling—Home Goal				
-2	**-1**	**0**	**+1**	**+2**
Prior to the start of each week:				
*P1 will accurately transfer 0% - 19% appointments for the week to his weekly calendar.	P1 will accurately transfer 20% - 39% appointments for the week to his weekly calendar.	P1 will accurately transfer 40% - 59% appointments for the week to his weekly calendar.	P1 will accurately transfer 60% - 79% of appointments to his weekly calendar. **ACHIEVED^{P}**	P1 will accurately transfer 80% - 100% of appointments to his weekly calendar. **ACHIEVED^{M}**
Goal 2: Planning—Home Goal				
Prior to the start of each week:				
*In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 0% - 19% of appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 20% - 39% of appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 40% - 59% of appointments for 1 week. **ACHIEVED^{M}**	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 60% - 79% of appointments for 1 week.	In his phone planner, P1 will accurately select a reasonable "travel time" and "alert time," as well as type two activities he needs to do before departing for 80% - 100% of appointments for 1 week. **ACHIEVED^{P}**
Goal 3: Arriving on Time—Home Goal				
*P1 will arrive prepared and on time for 0% - 19% of appointments across 1 week.	P1 will arrive prepared and on time for 20% - 39% of appointments across 1 week.	P1 will arrive prepared and on time for 40% - 59% of appointment across 1 week.	P1 will arrive prepared and on time for 60% - 79% of appointments across 1 week.	P1 will arrive prepared and on time for 80% - 100% of appointments across 1 week. **ACHIEVED$^{P, M}$**

* = Baseline Score, ^{P} = Post-treatment, ^{M} = Maintenance

P1 received a total of 16, 60-minute training sessions using his various scheduling external aids, with 6 sessions devoted to training in his cellphone calendar application and 2 sessions devoted to co-constructing GAS goals. There was one, 2-week break between weeks 3 and 4 during the study, and P1 attended bi-weekly sessions for 4 of 7 treatment weeks, and attended the remaining 6 sessions once per week. See Figures 2-4 to track P1's goal attainment throughout the study.

GAS and Goal Attainment.

Lab Goals. Following treatment, P1 improved in all three of his Lab Goals from *much less than expected* (-2) to *much more than expected (+2)*, as reflected in Table 2A and Figures 2-4. He maintained his improvement for one-month following treatment. Though not captured by his goals, the efficiency with which P1 was able to complete the probe of his goals is noteworthy; Goals 1 and 2 were completed in half the time at the 1-month maintenance than at post-treatment.

Home Goals. P1 also improved in all three of his Home Goals following the treatment, achieving above expectations for all three goals. At the one-month maintenance assessment, he met or exceeded expectations for all three goals. Home goals were heavily dependent on P1's completion of Home Goal tasks each week (e.g., scheduling his week). P1 did not schedule his week during the week of Probe 4, resulting in a dramatic drop in his GAS score for Home Goal 1. P1 consistently did not plan his week (Home Goal 2), resulting in a flat goal attainment level of -2. However, during Week 5 for Lab Goals, we see improvement in his ability to schedule and plan his week in Lab Goals 1 and 2, respectively. Home Goal data were not able to be collected until week 4. See Figures 2-4.

Aggregated *T*-scores were also calculated for P1's Lab Goals using methods reported by (Michele Grant et al., 2012; Turner-Stokes, 2009; see Figure 5). P1's baseline T-score improved from -22.9 (below expected outcomes) to 77.1 (above expected outcomes) post-treatment per guidelines proposed by Grant et al. (2012; expected outcome range equaling 40-60). P1 maintained this *T*-score at the maintenance phase. T-scores were not calculated for Home Goals because baseline scores were not collected.

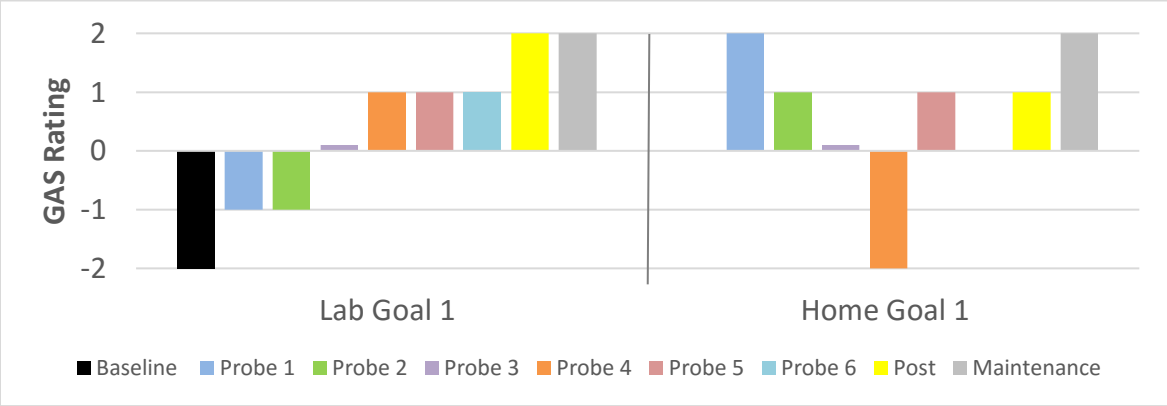


Figure 2. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 1 (Scheduling) for P1.

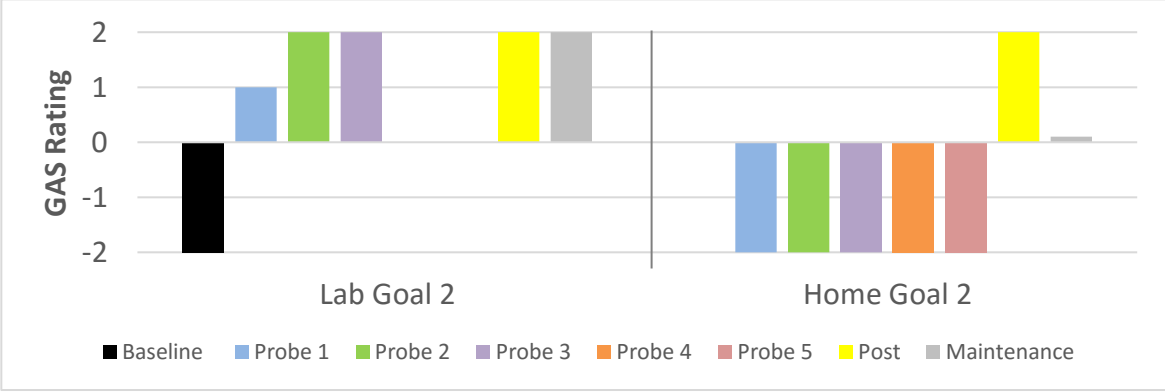


Figure 3. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 2 (Planning) for P1.

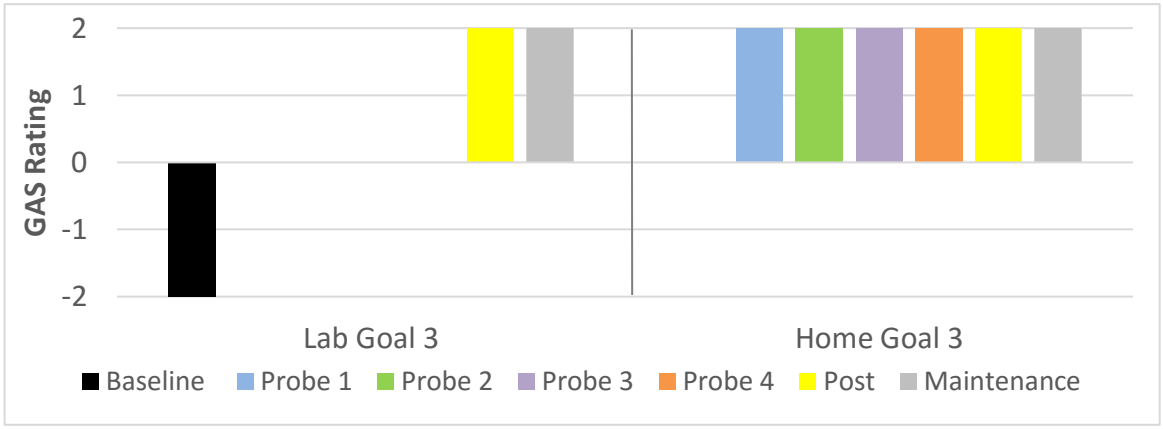


Figure 4. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 3 (Arriving on Time) for P1.

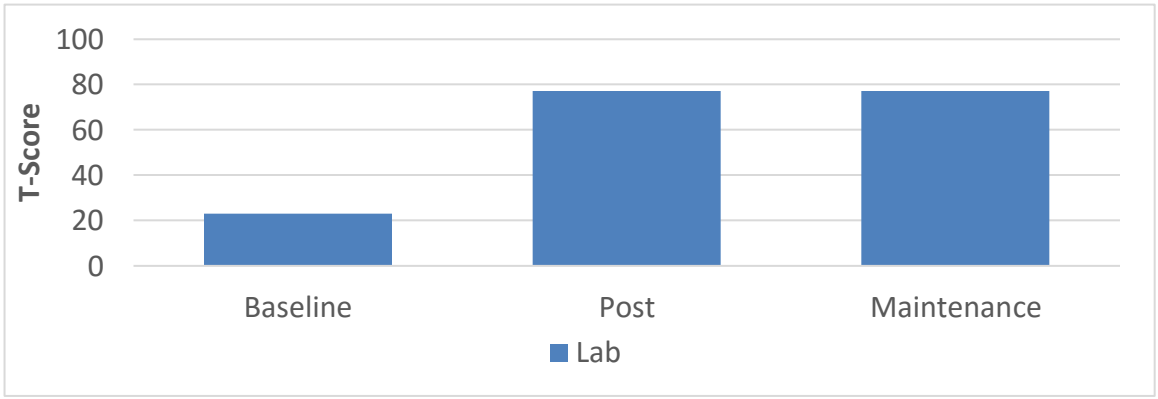


Figure 5. Aggregated T-scores reflecting P1's Lab Goals.

Descriptive measures.

Quality of Life Questionnaires. As reflected in Table 3, P1 improved considerably on the Parkinson Disease Questionnaire (PDQ-8) from baseline to maintenance, indicating improved functioning and well-being. He also moved from a score reflecting mild depression during baseline to no depression during the maintenance period according to the Beck Depression Inventory (BDI-II). On the BRIEF-A Self Report, P1 showed marked improved in his Global Executive Composite Score at post-treatment (specifically in the categories of initiation, working memory, planning/organizing, task monitoring and organization of materials), and maintained his improvements at the one-month maintenance assessment. His spouse also reported a

relatively stable Global Executive Composite Score for P1 between post-treatment and maintenance, with mild improvements noted in shifting, working memory and organization of materials on the BRIEF-A Informant Report. See Appendix G to view P1's BRIEF-A Report Forms. P1 had fewer concerns regarding his cognitive abilities immediately after treatment, as reflected on the PROMIS Applied Cognition Form; however, concerns rose beyond the baseline mark during maintenance. A small improvement was seen on P1's PROMIS-Satisfaction Questionnaire.

Compensatory Techniques Inventory (Appendix H).

Independence Screen. From baseline to the maintenance period, P1's self-perceived independence increased in 6/9 Life Tasks (e.g., making appointments, financial management, etc.), was maintained for 2/9, and slightly worsened for 1/9 (independence with driving). P1's spouse also noted more independence in P1's ability to complete Life Tasks, with 2/9 tasks reflecting improvement and 7/9 tasks reflecting stability of independence from post-treatment to maintenance (baseline questionnaires were not submitted).

Functional Cognition Screen. Between baseline and maintenance, P1 reported improvement on 2/11 cognitive issues (missing appointments, losing keys), and a decline in 1 area (return to task when interrupted); the remaining 8 areas reflected stability. His spouse also reported improvement from post-treatment to maintenance in 5/11 cognitive issues (losing keys, double scheduling, forgetting to complete tasks, having trouble organizing days, and starting but not finishing tasks), but a decline in 2 areas (don't know what appointments are coming up next week, cannot stay focused and return to task when interrupted).

Table 3. Descriptive measures across participants and questionnaires.

	Participant	Baseline	Post-Treatment	Maintenance
Parkinson Disease Questionnaire (PDQ-8) *Single Index of functioning and well-being:* *0 = no effect of PD* *100 = severe impact of PD.*	**P1**	15.625	9.375	3.125
	P2	12.5	9.375	15.625
	P3	65.625	62.5	71.85
	AVG (SD)	**31.12 (29.8)**	**27.08 (30.7)**	**42.7 (36.6)**
Beck Depression Inventory-II *0-10 = within normal limits; 11-16 = mild mood disturbance; 17-20 = borderline depression*	**P1**	13	8	7
	P2	6	2	3
	P3	19	20	19
	AVG (SD)	**12.67 (6.5)**	**10.0 (9.2)**	**9.67**
BRIEF-A: Self-Report *Global Executive Composite Score* *(T-scores ≥ 65 are considered clinically significant)*	**P1**	T-score: 48 Percentile: 55th	T-score: 40 Percentile: 31st	T-score: 40 Percentile: 31st
	P2	T-score: 64 Percentile: 92nd	T-score: 68 Percentile: 94th	T-score: 61 Percentile: 85th
	P3	T-score: 77 Percentile: 99th	T-score: 74 Percentile: 98th	T-score: 76 Percentile: 99th
	AVG	**63**	**60.67**	**59**
BRIEF-A: Informant Version *Global Executive Composite Score (T-scores ≥ 65 are considered clinically significant)*	**P1**	Not returned	T-score: 51 Percentile: 70th	T-score: 49 Percentile: 64th
	P2	T-score: 62 Percentile: 84th	T-score: 49 Percentile: 62nd	T-score: 53 Percentile: 73rd
	P3	T-score: 64 Percentile: 86th	T-score: 60 Percentile: 79th	T-score: 49 Percentile: 31st
	AVG	**N/A**	**53.33**	**54.3**
PROMIS- Applied Cognition, General Concerns, Short-Form 6a *(Lower scores = fewer concerns; total raw score = 30)*	**P1**	Raw score: 16 T-score: 42.4	Raw score: 10 T-score: 36.7	Raw score: 22 T-score: 48.7
	P2	Raw score: 28 T-score: 56.4	Raw score: 16 T-score: 42.4	Raw score: 19 T-score: 45.7
	P3	Raw score: 25 T-score: 52.2	Raw score: 20 T-score: 46.5	Raw score: 22 T-score: 48.7
	AVG	**Raw score: 23** **T-score: 49.9**	**Raw score: 15.3** **T-score: 41.5**	**Raw score: 21** **T-score: 47.6**
PROMIS- Satisfaction with Participation in Social Roles, Short-Form 6a *(Higher scores = more satisfaction; total raw score = 30)*	**P1**	Raw score: 17 T-score: 43.6	Raw score: 21 T-score: 48	Raw score: 19 T-score: 45.7
	P2	Raw score: 22 T-score: 49.2	Raw score: 29 T-score: 59.6	Raw score: 24 T-score: 51.7
	P3	Raw score: 9 T-score: 35.2	Raw score: 11 T-score: 37.5	Raw score: 16 T-score: 42.5
	AVG	**Raw score: 16** **T-score: 42.5**	**Raw score: 20.3** **T-score: 46.8**	**Raw score: 19.7** **T-score: 45.7**

Note. BRIEF-A = Behavior Rating Inventory of Executive Functions- Adult Version; PROMIS = Patient Reported Outcome Measurement Information System

Compensation Use. At baseline, P1's spouse scheduled all of P1's appointments, and they used a central wall calendar and individual pocket calendars to coordinate schedules; P1 did not use his cellphone calendar application to schedule appointments. At post-treatment, P1 reported on the CTI form that he frequently used his cellphone to schedule his appointments, and continued to use his phone for scheduling one-month following the study, however less frequently. P1's spouse reported that P1 continued to frequently use his phone for scheduling across post-treatment and maintenance phases. P1 used several other external aids during this study which can be reviewed in Appendix H.

Interview. The following table provides a summary of statements and quotes by P1 and his spouse, reflecting how they perceived the study and its impact on their lives.

Table 4. Interview Comments from P1 and P1 Spouse.

Person	Comments
P1	***Post-Treatment:*** P1 reported he was generally much more aware of his schedule by looking at his wall calendar in tandem with scheduling his appointments on his phone. He reported that he increased his ability to leave at the right time from ¼ to ½ of the time. He also reported he reduced anxiety about the idea of scheduling with his phone than prior to the study, and that he makes it to almost all of his appointments on time, which was a remarkable improvement from prior to the study. He stated that the study improved communication with his spouse regarding scheduling, which also improved his ability to plan and arrive on time to appointments. ***Maintenance****:* P1 reported he was increasingly leaving at the right time (about 100% of the time), and that he was arriving on time to almost all appointments. ***Remaining concerns:*** P1 reported that he had not used his cellphone to schedule and plan appointments between post-treatment and maintenance assessments.
Spouse	***Post-Treatment:*** "I'm so grateful! It is noticeable that [P1] does a better job knowing what time to leave. He gathers up his stuff, and has it ready; he gets in the car at the right time… He knows when to leave without me reminding him… He spends more time with scheduling, and is more focused on making the schedule work every day, and he looks at wall calendar more frequently."

	P1's spouse also indicated that his fatigue continues to be a barrier in making it to all appointments on time; however, P1 reportedly was late for all appointments prior to the study and was now arriving on time to almost all of his appointments. ***Maintenance:*** No significant changes in P1's ability to schedule, plan, or arrive on time to appointments from post-treatment assessment. ***Remaining concerns:*** P1's spouse reported P1 still continues to have difficulty emailing and taking different perspectives. She is also concerned about his declining memory function.

Control Goal. As anticipated, P1 did not significantly improve in his ability to solve a higher level 'logic puzzle,' which required cognitive functions such as alternating attention, mental flexibility, working memory, process of elimination, and reasoning. His baseline score (7/20) did not change appreciably during post-treatment (8/20) or maintenance (6/20).

Summary. P1 demonstrated marked improvement across his Lab and Home Goals, and he met or exceeded expectations at the 1-month maintenance assessment. His improvements were also reflected in his interview and quality of life questionnaires. The frequency and efficiency of use of his external aid (cellphone calendar application) increased and his anxiety in scheduling reduced. His spouse continued to schedule P1's appointments, but P1 was more independent in keeping track of his schedule and planning and leaving for appointments on time following the study. Though he was experiencing increased cognitive challenges at the maintenance period, his depression reduced and he maintained his ability from post-treatment to manage his schedule.

Participant Two

Initial Assessment. P2 presented with mild impairments in attention, memory and organization, as determined by the baseline interview, self-reported questionnaires, and formal

testing via the RBANS. Her deficits in memory caused her to miss several appointments per week, take medications inconsistently, and misplace her keys and wallet. Her organization deficits resulted in an unorganized desk and filing cabinet. At baseline, P2 used the following tools with intermittent success to help her schedule and organize her items: iPhone to schedule appointments, a filing cabinet, a small single-unit pill container, and post-it notes. Approximately 60% of her appointments were scheduled correctly, and she demonstrated excellent cellphone navigation abilities.

Goals. P2's self-selected goals included improving her ability to (1) take her medications consistently, (2) find misplaced items, (3) organize her desk and filing cabinets, and (4) increase her independence in scheduling and arriving to all her appointments. To help achieve this fourth goal, three sub-goals were developed, including scheduling appointments using her cellphone, scheduling appointments while she was on the phone with businesses/medical offices/friends, and regularly checking her cellphone schedule. Each of these goals were written as Home Goals and Lab Goals. See Table 5 for a summary of P2's goals, and Tables 6A-6G to view select Lab and Home Goals (remaining goals can be viewed in Appendix F).

Description of external aid selection. P2 received a total of 16, 60-minute training sessions using her various external aids, with 2 sessions devoted to co-constructing GAS goals and 14 sessions devoted to training of her goals. There was one, 1-week break between weeks 4 and 5 during the study, and P1 attended bi-weekly sessions for 7 of 7 treatment weeks. The theme of P2's training and external aids was focused on organization, specifically how to increase her ability to be organized with her medication regimen, desk, daily items, and schedule.

Medication Management. P2 was given a medication box organizer with individual day containers, each segmented into morning, noon, evening and night compartments. This organizer

Table 5. Summary of P2's Lab and Home Goals and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

GOAL		DESCRIPTION	GAS SCORE		
			BASELINE	POST	MAINTEANCE
Lab Goal 1 Medication Management	1A	Taking Medications: Accuracy	-2	2	2
	1B	Taking Medications: Effort	NB	2	0
	1C	Alarm + Medications	-2	2	2
Lab Goal 2 Tile Finder	2A	Finding Items	0	2	1
	2B	Efficiency of Finding Items	1	1	0
Lab Goal 3 Desk Organization	3A	Average number of objects correctly organized	1	2	2
	3B	Number of trials with 100% accuracy	-2	2	1
	3C	Efficiency of Desk Organization	-1	0	0
Lab Goal 4 Schedule Appointments while on Phone	4A	Number of trials P2 remains on the phone	2	1	2
	4B	Scheduling while on phone: Accuracy	0	2	2
	4C	Efficiency of scheduling appts while on phone	-2	0	0
Lab Goal 5		Checking her daily calendar	0	2	2
Lab Goal 6		Schedule her week on her iPhone	-2	0	1
Home Goal 1 Medication Management	1A	Taking Medications: Accuracy	0	2	2
	1B	Taking Medications: Effort	1	0	2
	1C	Filling Medications: Accuracy	-2	2	0
	1D	Filling Medications: Effort	0	2	2
	1E	Alarm + Medications	-2	1	N/A
Home Goal 2 Tile Finder	2A	Frequency of Use	-1	-1	N/A
	2B	Success	N/A	-1	1
	2C	Efficiency	N/A	2	-1
Home Goal 3 Desk Organization	3A	Frequency	1	1	1
	3B	Accuracy	-2	2	2
	3C	Effort	-1	2	2
Home Goal 4		Schedule Appts while on the phone	N/A	2	2
Home Goal 5		Checking her daily calendar	-2	-2	-1
Home Goal 6		Schedule Week	1	2	2
Home Goal 7		Arrive on Time for Appointments	0	2	2

N/A = Data not available

was selected because small size and portability were determined to be important features for P2, as she attended many appointments and activities per day. Alarms were paired with medication administration times to facilitate a more consistent medication regimen (Home Goal 1A). P1 received training in how to physically remove her individual day containers out of the medication organizer and how to select the corresponding time compartments. She also received systematic training in how to improve the accuracy of pills she placed in her medication box at the beginning of the week via checking a medication checklist while placing simulated medications into their respective containers (Home Goal 1C). To maximize her PD medication effectiveness, P2 learned how to set alarms to remind her to take her medications 30 minutes following a meal. Please note that no maintenance data for this goal (Home Goal 1E) was collected as P2 started to automatically adjust her medication administration times around her meals; this practice became embedded into her routine for the majority of the study.

Desk Organization. Based on photographs, none of P2's objects on her desk or filing cabinet were organized at baseline. To improve her desk organization, P2's desk was segmented by blue tape into the individual compartments/categories paired with labels. Desk categories included notes, to-do lists, grocery lists, jewelry, ongoing projects, and pens. The organization of P2's home desk matched the desk used in the lab to facilitate carryover and generalization between settings. P2 was also given labeled files for her filing cabinets, again matching the files used for training purposes in the lab. She received systematic instruction on how to organize different notes, papers and objects into their respective location. Daily alarms alerted P2 to organize her desk and filing cabinet.

Misplacing Items. To facilitate her ability to find her misplaced items quickly (e.g., phone, keys, and wallet), P2 was given a Tile Bluetooth tracker. P2 only received approximately

20 minutes of training in how to use this device due to time constraints of the study. At maintenance, P2 reported she did not lose her items at all, and credited this to her overall improvement in her desk organization, as she created a labeled space for her keys and wallet.

Scheduling. To increase her ability to arrive to all her appointments across the week, P2 received training on how to use voice command to schedule appointments and navigate her daily schedule when alerted by alarms on her phone. Please note that her lower than expected goal attainment for checking her daily schedule (Home Goal 5) was due to her automaticity in checking her schedule multiple times per day, and not following alarms; once again, this behavior became embedded into her daily routine once exposed to multiple alarms per week. P2 also received training on how to schedule appointments while on the phone, which included navigating to her calendar and finding an appropriate date/time to schedule an appointment. At post-treatment and maintenance, P2 was missing 0 appointments per week.

Table 6A. Lab Goal 1 (medication management) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 1: Medication Management, Part A (Taking Meds-Accuracy)				
-2	**-1**	**0**	**+1**	**+2**
Across 7 trials, when given a pill organizer and audible + visual alarms (prompting her to take meds) P2 will…				
*Make 4 mistakes	Make 3 mistakes	Make 2 mistakes	Make 1 mistake	Make 0 mistakes **ACHIEVED^{P,M}**
Note. Mistakes are defined as choosing the wrong day and/or time compartment: morning, noon, evening, bed.				
Lab Goal 1: Medication Management, Part B (Taking Meds-Effort)				
Across 7 trials, The effort it takes P2 to take the correct medications will be				
^{NB}Extremely Effortful	Extremely—moderately effortful	Moderately effortful **ACHIEVED^{M}**	Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{P}**

Lab Goal 1: Medication Management, Part C (Alarm + Meds)				
When given the scenario that she is eating a meal while her alarm activates, P2 will accurately set an alarm for 45 minutes titled "take pills" (prompting her to take pills at the later time)…				
*0 times.	1 time.	2 times.	3 times.	4 times. **ACHIEVED[P,M]**

[P] = Post-treatment, [M] = Maintenance * = Baseline Score [NB]= No Baseline Score

Table 6B. Lab Goal 3 (desk organization) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 3: Desk Organization, Part A				
-2	**-1**	**0**	**+1**	**+2**
*Across 5 trials: When given 15 notes and objects, triggered by an audible + visual alarm prompting task, P2 will correctly organize (on **average**):*				
0-3 objects into their designated spaces	4-6 objects into their designated spaces.	7-9 objects into their designated spaces	*10-12 objects into their designated spaces	13-15 objects into their designated spaces. **ACHIEVED[P,M]**
Lab Goal 3: Desk Organization, Part B (All correct)				
Across 5 trials: When given 15 notes and objects, triggered by an audible + visual alarm prompting task, P2 will:				
*Correctly organize all objects into their designated spaces for 0-1 of 5 trials.	Correctly organize all objects into their designated spaces) for 2 of 5 trials.	Correctly organize all objects into their designated spaces for 3 of 5 trials.	Correctly organize all objects into their designated spaces for 4 of 5 trials. **ACHIEVED[M]**	Correctly organize all objects into their designated spaces for 5 of 5 trials. **ACHIEVED[P]**
Lab Goal 3: Desk Organization, Part C				
*Across 5 trials: When given 15 notes and objects, triggered by an audible + visual alarm prompting task, P2 it will take her **(on average)***				
4 -5 minutes to organize items.	*3- 4 minutes to organize items.	2 -3 minutes to organize items. **ACHIEVED[P,M]**	1 -2 minutes to organize items.	0 - 1 minutes to organize items.
Designates spaces include on the desk and in hanging files beside desk.				

* = Baseline Score, [P] = Post-treatment, [M] = Maintenance

Table 6C. Lab Goal 6 (scheduling week) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 6: Scheduling Her Week				
-2	**-1**	**0**	**+1**	**+2**
When given a list of 4 appointments to schedule:				
*Using voice command, P2 will accurately schedule 0 appointments into her phone calendar.	Using voice command, P2 will accurately schedule 1 appointment into her phone calendar.	Using voice command, P2 will accurately schedule 2 appointments into her phone calendar. **ACHIEVED^{P}**	Using voice command, P2 will accurately schedule 3 appointments into her phone calendar. **ACHIEVED^{M}**	Using voice command, P2 will accurately schedule 4 appointments in her phone calendar.

* = Baseline Score, ^{P} = Post-treatment, ^{M} = Maintenance

Table 6D. Home Goal 1 (medication management) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 1: Medication Management, Part A (Taking Meds-Accuracy)				
-2	**-1**	**0**	**+1**	**+2**
When given a pill organizer and audible + visual alarms (prompting her to take meds) P2 will…				
Make 4 mistakes	Make 3 mistakes	*Make 2 mistakes	Make 1 mistake	Make 0 mistakes **ACHIEVED^{P,M}**
Note. P2 takes pills 3 times/day, 7 days/week, equaling 21 times/week she needs to take pills. Mistakes are defined as taking medications at the wrong time, not taking medications, or taking medications from an incorrect day or compartment: morning, noon, evening, bed.				
Home Goal 1: Medication Management, Part B (Taking Meds-Effort)				
When given a pill organizer and audible + visual alarms (prompting her to take meds); The effort it takes P2 to take the correct medications will be				
Extremely Effortful	Extremely—moderately effortful	Moderately effortful **ACHIEVED^{P}**	*Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{M}**
Home Goal 1: Medication Management, Part C (Filling Meds-Accuracy)				
Across 1 week, she will be ____% accurate in correctly filling her pills in her pill organizer:				
*80%	85%	90% **ACHIEVED^{M}**	95%	100% **ACHIEVED^{P}**

Home Goal 1: Medication Management, Part D (Filling Meds-Effort)				
The effort it takes P2 to correctly fill her pills in her pill organizer will be:				
Extremely effortful	Extremely-Moderately Effortful	*Moderately Effortful	Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{P,M}**
Home Goal 1: Medication Management, Part E (Alarms + Meds)				
If alarm for medication activates when she is eating a meal, P2 will set alarm for 45 minutes (prompting her to take pills at the later time)…				
*None of the time.	Some of the time.	Half of the time.	Most of the time. **ACHIEVED^{P}**	All of the time.

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

Table 6E. Home Goal 3 (desk organization) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 3: Desk Organization, Part A				
-2	**-1**	**0**	**+1**	**+2**
When daily audible and visual alarm activates, P2 will categorize objects on/in desk into their designated spaces…				
0 days per week.	1-2 days per week.	3-4 days per week.	*5-6 days per week. **ACHIEVED^{P,M}**	7 days per week.
Objects include ongoing projects (i.e. passport documentation), sticky notes, check-lists, daily notes, jewelry, paperwork, pencils/pens.				
Home Goal 3: Desk Organization, Part B				
On the final evening of the week, objects on/in her desk will be:				
*Not at all organized.	Somewhat organized.	Half will be organized.	Most will be organized.	All will be organized. **ACHIEVED^{P,M}**
Home Goal 3: Desk Organization, Part C				
The effort it takes P2 to organize her desk across one week will be:				
Extremely effortful	*Extremely-Moderately Effortful	Moderately Effortful	Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{P,M}**

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

Table 6F. Home Goal 6 (scheduling week) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 6: Scheduling Her Week				
-2	**-1**	**0**	**+1**	**+2**
Prior to the start of each week:				
P2 will accurately schedule 0-19% appointments into her phone calendar.	P2 will accurately schedule 20-39% of appointments into her phone calendar.	P2 will accurately schedule 40-59% of appointments into her phone calendar.	*P2 will accurately schedule 60-79% of appointments into her phone calendar.	P2 will accurately schedule 80-100% of appointments in her phone calendar. **ACHIEVED[P,M]**

[P] = Post-treatment, [M] = Maintenance * = Baseline Score [NB]= No Baseline Score

Table 6G. Home Goal 7 (arriving on time) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 7: Arriving on Time				
-2	**-1**	**0**	**+1**	**+2**
P2 will make it to (not miss)				
60% of appointments across 1 week.	70% of appointments across 1 week.	*80% of appointments across 1 week.	90% of appointments across 1 week.	100% of appointments across 1 week. **ACHIEVED[P,M]**

* = Baseline Score [P] = Post-treatment, [M] = Maintenance [NB]= No Baseline Score

GAS and Goal Attainment. See Figures 6-18 to track P2's GAS goal attainment across the study.

Lab Goals. At the 1-month maintenance period, P2 demonstrated improvement in 10/13 of her Lab Goals. For the goals in which she did not improve, baseline scores were not reported or her baseline goal attainment was already above expectations (+1 or +2). P2's baseline goal attainment was *much less than expected* (-2) for 5 goals, *less than expected* (-1) for 1 goal, *expected* (0) for 3 goals, *more than expected* (+1) for 2 goals, and *much more than expected* (+2)

for 1 goal. Baseline data were not collected for Lab Goal 1B. At post-treatment, P2 achieved +2 for 8 goals, +1 for 2 goals and 0 for 3 goals. She did not score below expected goal achievement at post-treatment for any goals. At maintenance, P2 achieved +2 for 6 goals, +1 for 3 goals and 0 for 4 goals. She did not score below expected goal achievement at maintenance for any goals. From post-treatment to maintenance, she maintained performance for 7 Lab Goals, improved for 2 Lab Goals, and achieved a slightly lower level of goal attainment for 4 goals.

Home Goals. At maintenance, P2 improved in 10/15 of her Home Goals. For the goals that did not reflect improvement, there were extraneous factors: (1) baseline or maintenance data were not collected, or (2) baseline goal attainment matched her score at maintenance, e.g., for Home Goal 2A. P2's baseline goal attainment was *much less than expected* (-2) for 4 goals, *less than expected* (-1) for 2 goals, *expected* (0) for 3 goals, *more than expected* (+1) for 3 goals, and *much more than expected* (+2) for 0 goals. Baseline data were not collected for Home Goals 2A, 2C and 4. At post-treatment, P2 achieved +2 for 9 goals, +1 for 2 goals, 0 for 1 goal, -1 for 2 goals, and -2 for 1 goal. At maintenance, P2 achieved +2 for 8 goals, +1 for 1 goals, 0 for 1 goal, -1 for 2 goals and -2 for 0 goals. Data were not able to be collected for 2 goals, Home Goals 1E and 2A. From post-treatment to maintenance, P2 maintained performance for 8 Home Goals, improved performance for 3 goals, and achieved a slightly lower level of goal attainment for 2 goals.

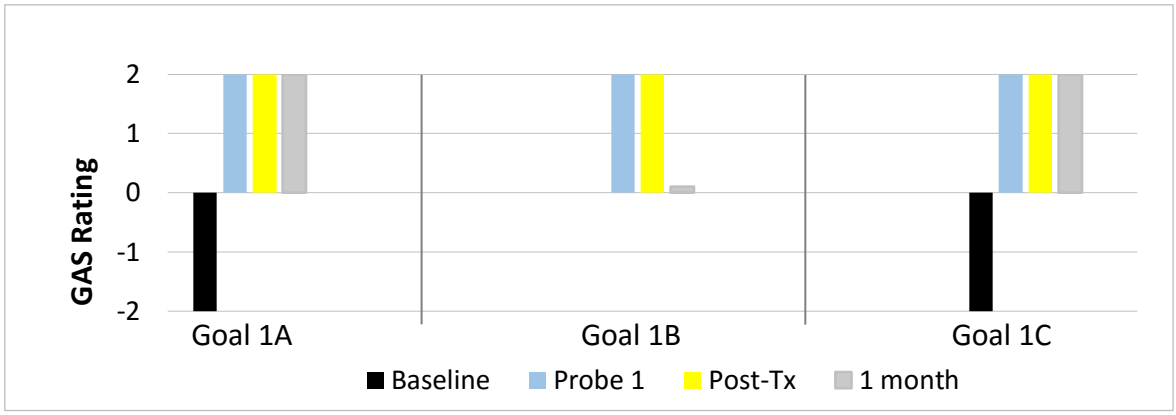


Figure 6. Goal Attainment Scale (GAS) ratings for Lab Goal 1 (Medication Management) for P2.

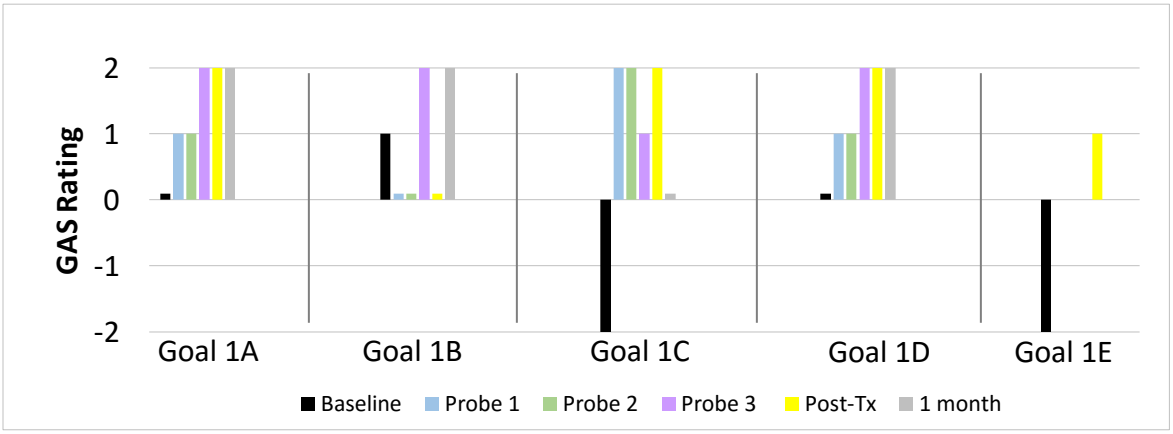


Figure 7. Goal Attainment Scale (GAS) ratings for Home Goal 1 (Medication Management) for P2.

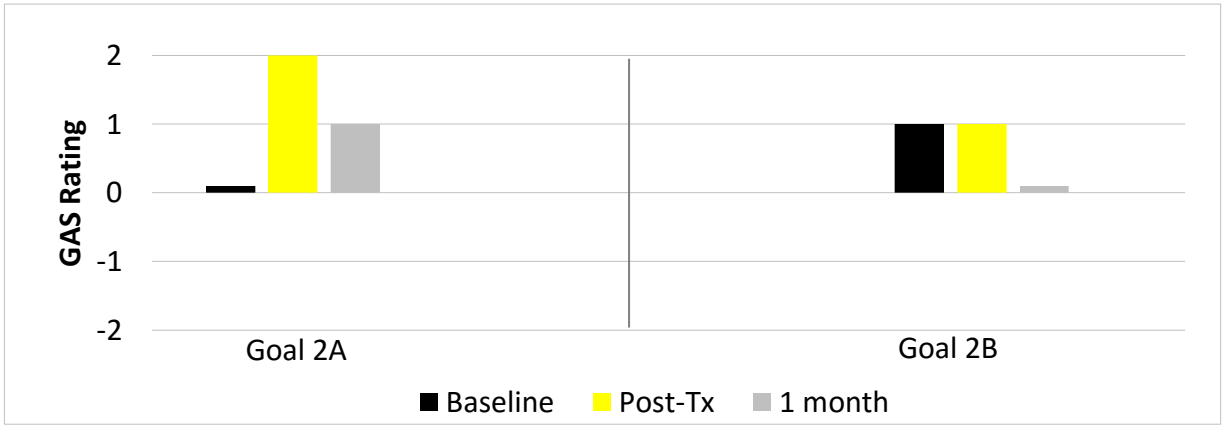


Figure 8. Goal Attainment Scale (GAS) ratings for Lab Goal 2 (Finding Misplaced Items) for P2.

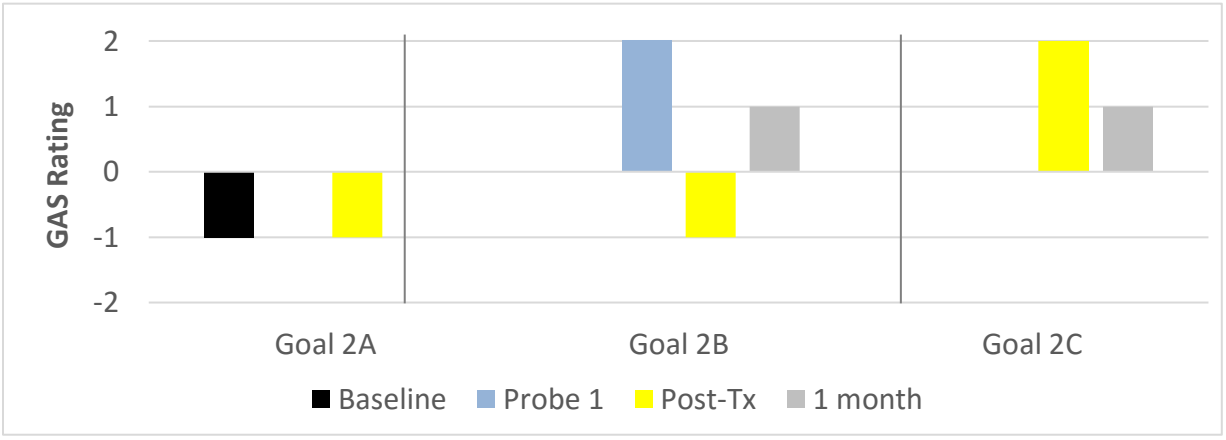


Figure 9. Goal Attainment Scale (GAS) ratings for Home Goal 2 (Finding Misplaced Items) for P2.

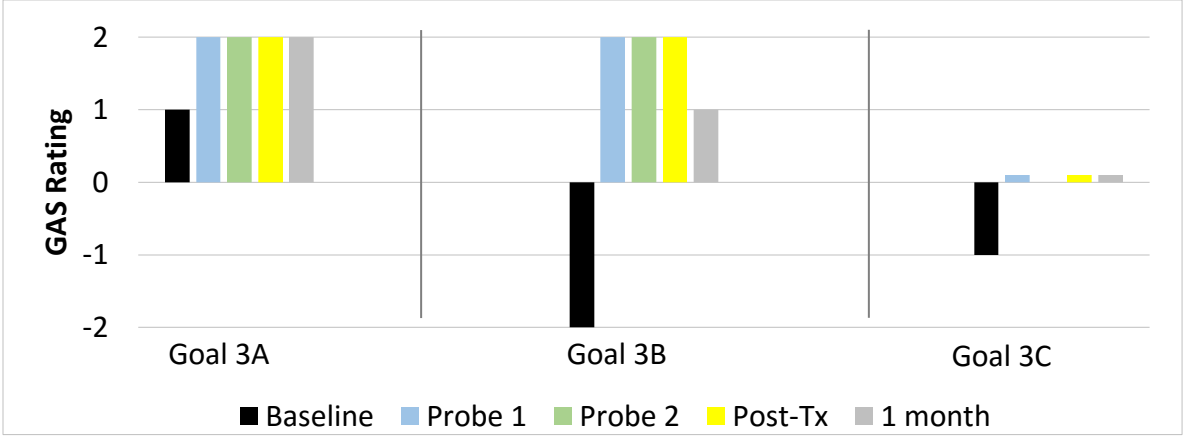


Figure 10. Goal Attainment Scale (GAS) ratings for Lab Goal 3 (Desk Organization) for P2.

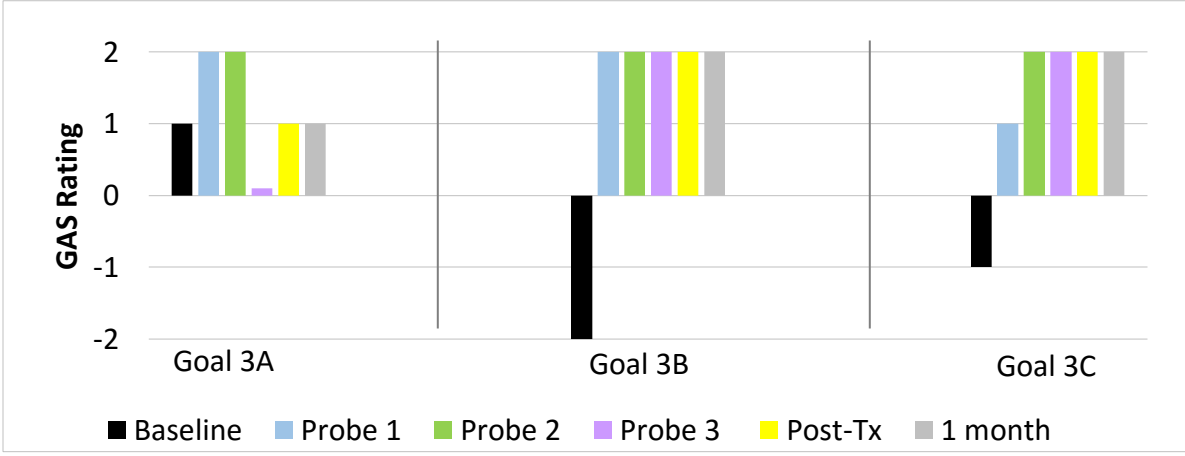


Figure 11. Goal Attainment Scale (GAS) ratings for Home Goal 3 (Desk Organization) for P2.

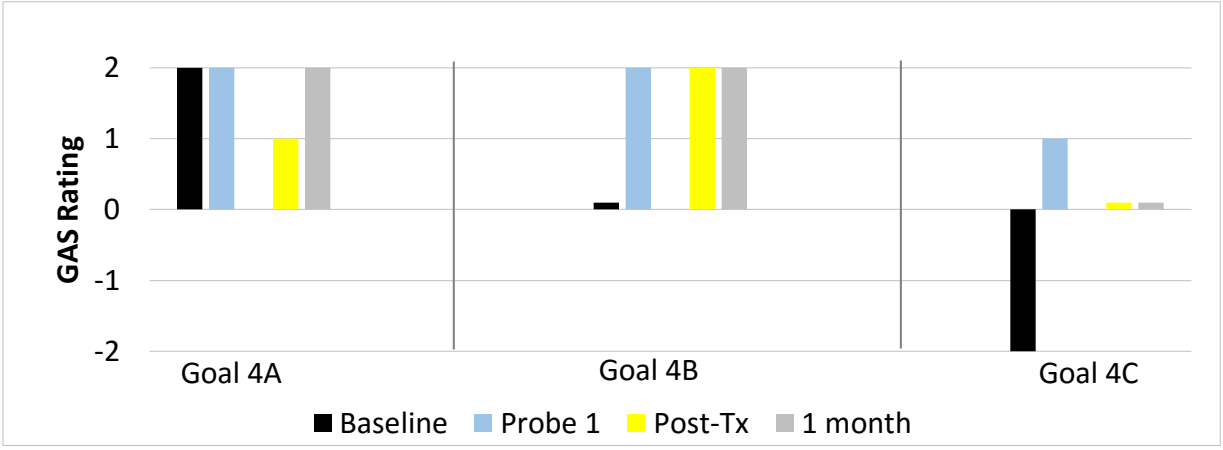


Figure 12. Goal Attainment Scale (GAS) ratings for Lab Goal 4 (Schedule Appointments while on Phone) for P2.

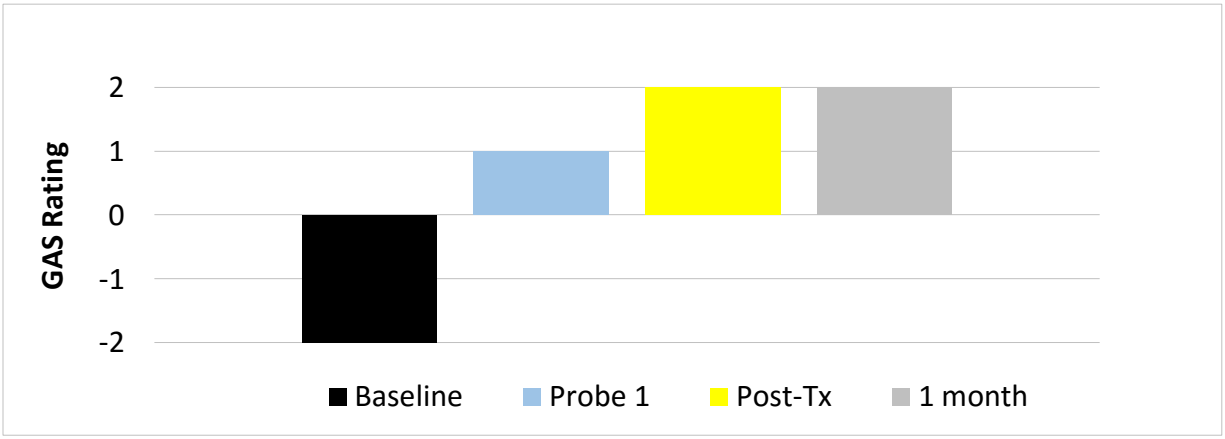


Figure 13. Goal Attainment Scale (GAS) ratings for Home Goal 4 (Schedule Appointments while on Phone) for P2.

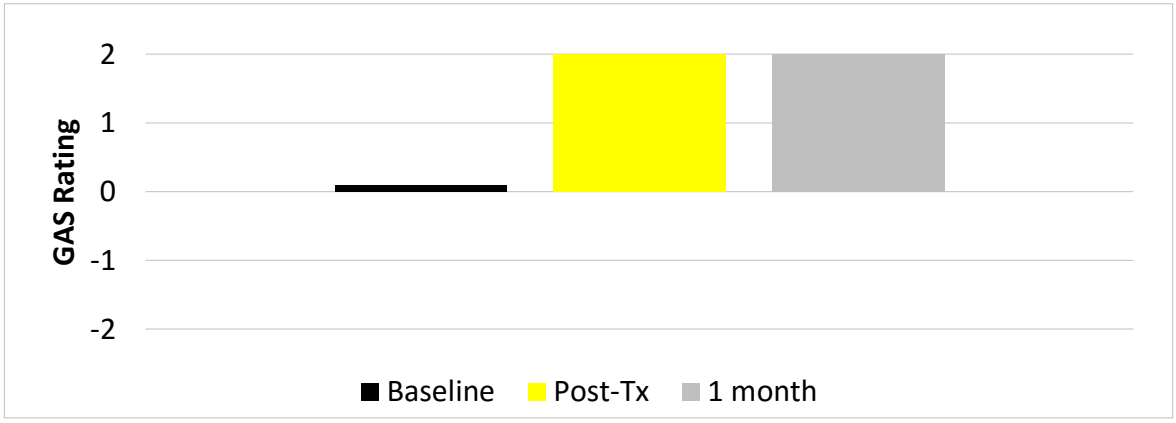


Figure 14. Goal Attainment Scale (GAS) ratings for Lab Goal 5 (Daily Calendar) for P2.

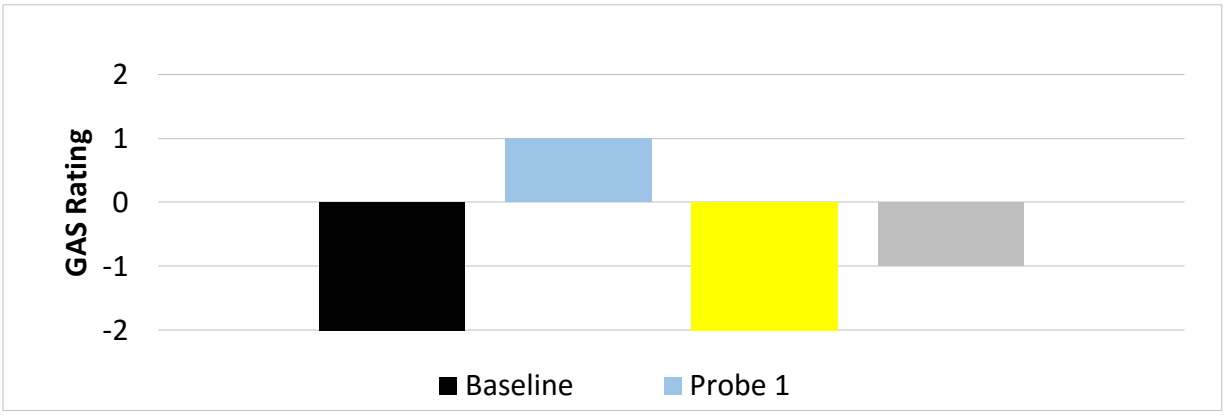


Figure 15. Goal Attainment Scale (GAS) ratings for Home Goal 5 (Daily Calendar) for P2.

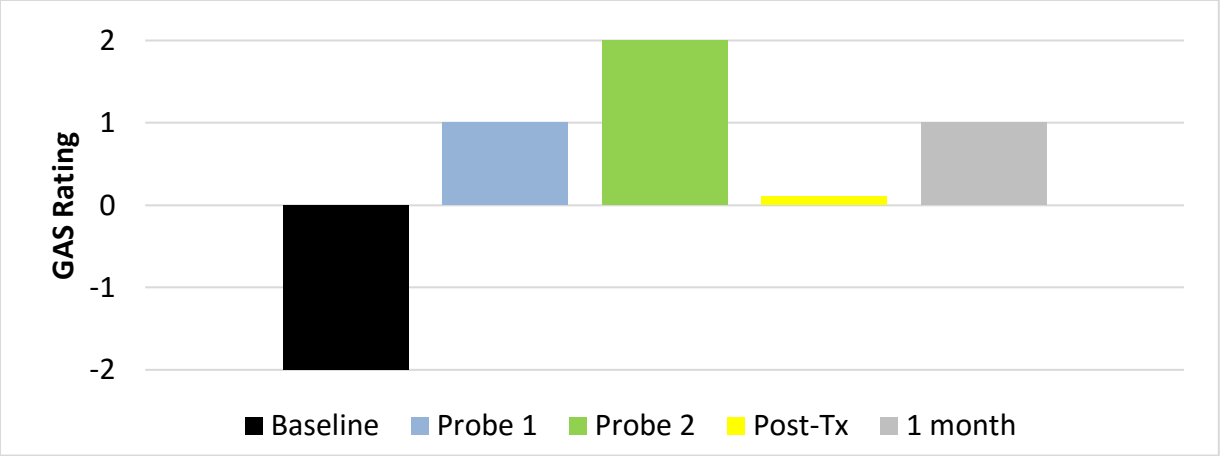


Figure 16. Goal Attainment Scale (GAS) ratings for Lab Goal 6 (Scheduling the Week) for P2.

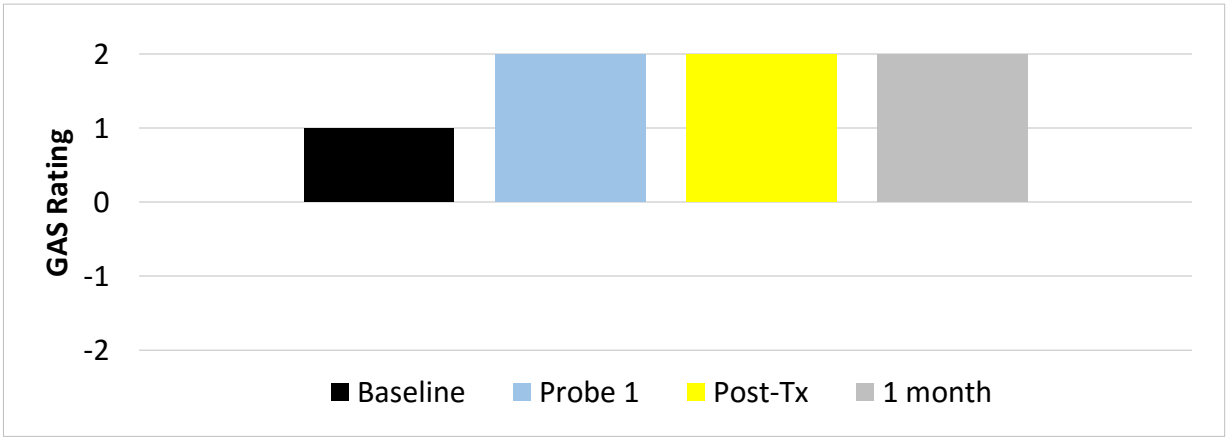


Figure 17. Goal Attainment Scale (GAS) ratings for Home Goal 6 (Scheduling the Week) for P2.

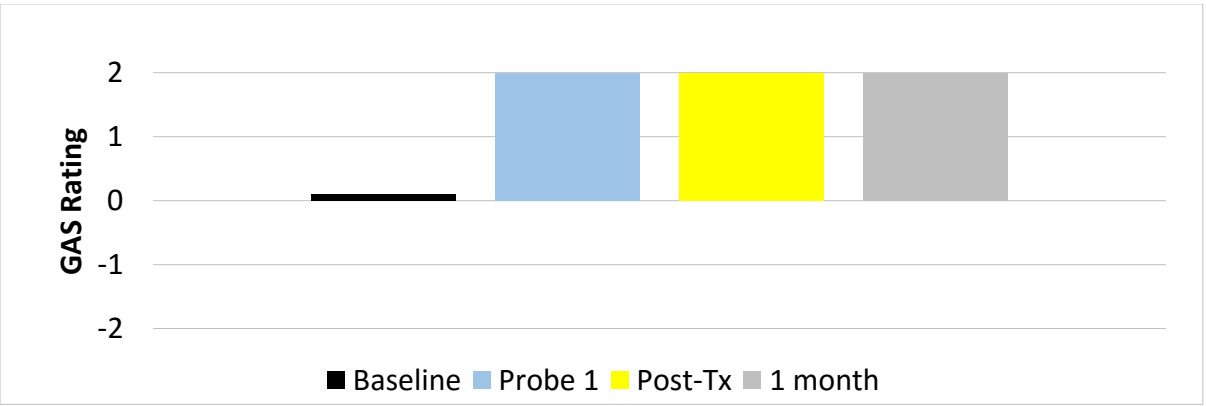


Figure 18. Goal Attainment Scale (GAS) ratings for Home Goal 7 (Arrive on Time) for P2.

T-scores were calculated for P2's Lab and Home Goals when baseline scores were consistent across goals (e.g., all baseline scores equaled -2). Goals were then collectively aggregated across goal type (Lab and Home) and baseline score (-2, -1 and 0). *T*-scores were not calculated for goals with a baseline score of 1 or 2. On average, P2's *T*-scores improved across each goal attainment level and goal type, with the greatest change in *T*-score noted for goals starting with a baseline of -2. When all Lab Goals and Home Goals were measured collectively, an aggregated *T*-score was 30.1 at baseline (below expected outcomes), 74.5 at post-treatment (above expected outcomes), and 71.5 at maintenance (above expected outcomes) per guidelines proposed by Grant et al. (2012), with the expected outcome range equaling 40-60. See Figure 19 to view P2's *T*-scores at baseline, post-treatment and maintenance phases across the study.

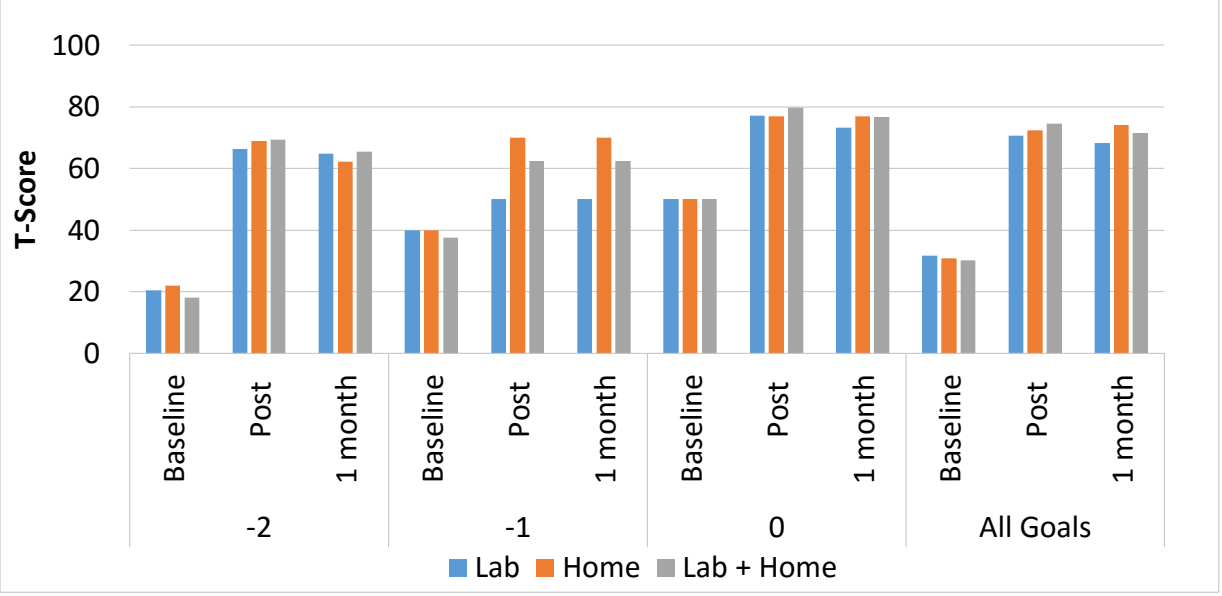


Figure 19. T-scores reflecting aggregated Lab and Home Goals for P2.

Descriptive measures.

Quality of Life Questionnaires. As reflected in Table 3, P2 reported small improvements in functioning immediately post-treatment per the PDQ-8, though scores slightly worsened beyond baseline during the maintenance phase. Her depression scores also slightly reduced per

the BDI-II. On the BRIEF-A Self Report, P2 demonstrated improvement on the Global Executive Composite Score during the maintenance phase, with the most prominent self-perceived improvement in working memory and organization of materials indexes. Her spouse also reported improved scores on the BRIEF-A Informant Report, particularly immediately post-treatment. See Appendix G to view P2's BRIEF-A Report Forms. P2 had fewer concerns regarding her cognitive abilities per the PROMIS Applied Cognition Form immediately after treatment, and her results were relatively consistent at the one-month maintenance assessment. A small improvement was also seen on P2's PROMIS-Satisfaction Questionnaire, particularly immediately post-treatment.

Compensatory Techniques Inventory (Appendix H).

Independence Screen. From baseline to maintenance, P2's self-perceived independence increased in 2/9 Life Tasks (e.g., driving and meal planning), and she reported she was completely independent or required reminders only in 8/9 Life Tasks during the maintenance period. P2's spouse also noted more independence in P2's ability to organize social arrangements. Her spouse indicated that P2 had maintained her independence in 6/9 tasks, with slight reduction in independence for 2/9 tasks, including making appointments and financial managements. P2's spouse again rated P2 to be completely independent or required reminders only in 8/9 life tasks.

Functional Cognition Screen. Between baseline and maintenance, P2 reported improvement on 5/11 cognitive issues (*don't know the date, losing keys*, *having trouble organizing days/tasks, start but don't finish tasks,* and *forget what I did yesterday*), with no decline in any areas. Her spouse also reported improvement from post-treatment to maintenance in 4/11 cognitive issues (*losing keys*, *having trouble organizing days/tasks, start but don't finish*

tasks, and *don't know what appoints are coming up),* and maintenance of skill in 6/11 areas. Both P2 and her spouse reported a decline in one area (forgot what I did yesterday).

Compensation Use. P2's pill organization system changed from a small, single compartment medication box at baseline to a weekly medication box with four time compartments per daily container at post-treatment and maintenance. She also transferred from a "take medications as needed" schedule at baseline to three daily cellphone alarms to alert P2 to take her prescribed medications. At baseline, P2 had no type of desk organization system. At post-treatment and maintenance, she was using the desk-organization system created in the study two times daily. Though P2 was occasionally using her Tile Bluetooth tracker at maintenance, she reported she was simply not misplacing her items near as much as she did prior to the study. P2 changed from scheduling her appointments via manual entry on her iPhone at baseline to using voice command at post-treatment and maintenance. P2 and her spouse continued to use a central calendar. P2 used several other external aids during this study which can be reviewed in Appendix H.

Interview. Table 7 provides a summary of statements and quotes by P2 and her spouse, reflecting how they perceived the study and its impact on their lives.

Control Goal. As anticipated, P2 did not significantly improve her score on the higher level 'logic puzzle,' control goal, which required cognitive functions such as alternating attention, mental flexibility, working memory, process of elimination, and reasoning. Her baseline score (6/20) did not change appreciably during post-treatment (8/20) or maintenance (7/20).

Table 7. Interview Comments from P2 and P2 Spouse.

Person	Comments
P2	***Post-Treatment:*** "I liked how practical this study was. It's nice to have a practical problem and fix it." *Medication Management***.** P2 stated that referring to a medication list was helpful and reduced her effort and anxiety in filling up her medication box. She reported she is taking her medications at the right time about 100% of the time, and felt like she didn't need all the alarms to remind her about administration times. *Desk Organization.* P2 stated she organized her desk 1-2 times a day, and found the structured desk organization system to be very helpful and reduced her anxiety about her projects. *Finding Misplaced Items.* P2 commented that she felt like she wasn't doing "well" when she used her Tile; however, she stated that having the Tile made her "feel more secure." *Scheduling.* P2 reported that scheduling appointments via voice command on her iPhone to be very helpful, and she was even teaching some of her friends how to use the feature. She reported she checks her daily schedule 2-3 times a day and missed 0 appointments in the last several weeks. ***Maintenance****:* P2 did not report any significant changes at maintenance, but expressed interest in removing some of the alarms as she felt many of the routines that were paired with alarms during the study (e.g., medication administration times) were well embedded into her routine. ***Remaining Concerns:*** P2 reported concerns regarding navigation, stating, "I still feel anxious about getting places on time and finding the right route." She also stated it is difficult for her to remember to fill her pills correctly in her pill organizer when the routine varied from the typical regimen (e.g., taking an extra half of a tablet on Mondays).
P2's Spouse	***Post-Treatment:*** "I think [the study] was great and very different from other speech therapy she's had. I liked how practical this study was for her, and how she worked on real life things." *Medication Management.* "The alarms made her stop and think, and help her keep on track." She commented that the pill box was difficult for P2 to use initially, but now P2 finds it very helpful. *Desk Organization.* "Having the structure helps her do the top of the desk really well. She regularly organizes her desk. She still has some difficulty with files, and finding things in her filing cabinet." *Finding Misplaced Items.* P2's spouse stated she hadn't seen P2 use the Tile Bluetooth tracker, but hasn't lost her phone, keys or wallet recently. *Scheduling.* "She is much better than she was before, and spends more time focused on scheduling." P2's spouse stated P2 uses the voice command frequently. ***Maintenance:*** P2's spouse indicated that though the alarms were sometimes "annoying" she stated that they were going to "think about keeping the alarms as they seem to help [P2]." She reported no significant changes in P2's ability to schedule, plan, or arrive on time to appointments from the post-treatment assessment. ***Remaining Concerns:*** P2's spouse reported that while P2 was not misplacing her key items used by her Tile Bluetooth Tracker, she was placing other items in the wrong places (e.g., putting things in the cupboard). P2's spouse also reported P2 has some difficulty finding papers in her filing cabinet.

Summary. P2 demonstrated marked improvement across her Lab and Home Goals, and met or exceeded expectations at maintenance for nearly all goals. The goals in which she did not reach expectations had limited training time or their goal attainment was determined by the external aid's frequency of use, not her ability to correctly use the tool. P2 reported functional improvements in her interview and quality of life measures, and her spouse reported similar observations. Her frequency and efficiency of use of her external aid (desk organization system, medication box organizer, cellphone calendar, and alarms) improved, and she was reportedly missing no appointments per week at post-treatment and maintenance phases.

Participant Three

Initial Assessment. P3 presented with moderate deficits in attention, short-term memory, planning and initiation, as determined by his and his spouse's comments during the baseline interview, self-reported questionnaires and formal testing via the RBANS. Similar to P1, he depended on reminders from his spouse to start getting ready for appointments. He also reported significant difficulty sending and receiving text-messages and generating to-do lists. He and his spouse also reported that he frequently lost his notes, and arrived late to appointments due to deficits in planning. At baseline, P3 used a Samsung smart phone to call contacts; he did not use it for texting and reported he had never texted before. He also used a pocket-calendar to assist with scheduling, and post-it notes to facilitate recall.

Goals. P3's self-selected goals included (1) improving his communication with friends and family via texting, (2) improving his ability to find and read his notes and prevent misplacing them, (3) reducing reminders from his wife to start getting ready for appointments,

and (4) improving his ability to plan out his days. Each of these goals were written as GAS Home Goals and Lab Goals (see Tables 8A-8J).

Description of external aid selection. P3 received a total of 16, 60-minute training sessions using his external aids, with 2 sessions devoted to co-constructing GAS goals and 14 sessions devoted to training of his goals. There was one, 1-week break between weeks 5 and 6 during the study, and P3 attended bi-weekly sessions for 5 of 7 treatment weeks and weekly sessions for the remaining four sessions. P3's therapy and external aids targeted improving his ability to use his cellphone and various applications to facilitate his texting, note organization, and scheduling abilities.

Noteworthy events. During the duration of the study, P3 sustained over 10 falls and hypoglycemic episodes, which impacted his attendance schedule. He was observed to have reduced energy and focus during sessions following these events.

Note Organization. P3 received 5 sessions of training in the note organization app, *Google Keep.* This app was selected to compensate for his poor legibility and to collectively place all his notes in one location, potentially preventing the loss of his notes. Color-coded categories were created to facilitate organization of his notes, including Doctor Appointments (with each of his doctors listed), a To-Do List, a Grocery List, Conversations with his wife and the study's investigator, and Clubs. P3 was trained to use voice command by pressing a small microphone icon within the app to facilitate the rate of his entries. With systematic instruction, P3 was able to quickly learn how to categorize grocery and to-do list notes, but required 3 sessions to learn the sequence of how to record a doctor's note (e.g., transferring information from a simulated doctor's visit summary), and often ran into difficulty with troubleshooting and finding the microphone icon. Immediately following training in this goal, he demonstrated *more*

than expected (+2) goal attainment for his Lab Goal, but showed limited carryover in his home setting, later reporting that he simply did not have as many notes to take as he initially thought. His spouse also reported that he continued to "stick with old habits" and take paper-pencil notes.

Scheduling. P3 received 4 sessions in how to use voice command with his cellphone to schedule his weekly appointments. A small 1x2 inch laminated sheet with typed instructions for scheduling using voice command was posted to the inside of his phone case to serve as an external visual cue. An electronic scheduler was selected to compensate for P3's poor legibility and because the application included an alarm feature. A default alarm was set for 95 minutes prior to the start of each event to alert him to start getting ready.

Day Planning. P3 was provided a dry erase marker and an 8 ½ X 11 inch laminated sheet with a variety of daily events separated by category, including appointments, hobbies, chores, and outings. The list was personalized over the course of the study by P3 and his spouse. A daily cellphone alarm was created to alert P3 to plan out his day each morning. Though this alarm remained on the phone throughout the duration of the study, P3 and his wife used the list at night to plan P3's day for the following day. P3 was provided 2 sessions in how to transfer day planning events to his cellphone calendar application.

Texting. P3 received 6 sessions in how to use voice command with his cellphone to send and reply to text messages. A small 1x2 inch laminated sheet with instructions on how to use voice command for texting was posted to the inside of his phone case to serve as an external visual cue. With systematic instruction, P3 was able to quickly learn how to compose text messages using voice command, and required 4 sessions to learn the sequence necessary to reply to a text message. Similar to the note organization goal, he often ran into the most difficulty with troubleshooting and finding the microphone icon.

Table 8A. Lab Goal 1 (Note Organization) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

-2	-1	0	+1	+2
When given 4 pieces of information (e.g. dr.'s orders, to-do items, conversation memos, etc.):				
*P3 will correctly categorize 0 items using the Google Keep App.	P3 will correctly categorize 1 item using the Google Keep App.	P3 will correctly categorize 2 items using the Google Keep App.	P3 will correctly categorize 3 items using the Google Keep App. **ACHIEVED^{P,M}**	P3 will correctly categorize 4 items using the Google Keep App.

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

Table 8B. Lab Goal 2 (Scheduling) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Given a list of 4 appointments to schedule:				
*P3 will accurately schedule 0 appointments into his phone calendar.	P3 will accurately schedule 1 appointment into his phone calendar.	P3 will accurately schedule 2 appointments into his phone calendar.	P3 will accurately schedule 3 appointments into his phone calendar. **ACHIEVED^{M}**	P3 will accurately schedule 4 appointments in his phone calendar. **ACHIEVED^{P}**

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

Table 8C. Lab Goal 3 (Planning his Day) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Part A				
When given 2 scheduled activities on his phone calendar and his Day Planning List:				
P3 will circle 0 'planning activities' on his Day Planning List.	P3 will circle 1 'planning activity' on his Day Planning List.	P3 will circle 2 'planning activities' on his Day Planning List.	*P3 will circle 3 'planning activities' on his Day Planning List.	P3 will circle 4 'planning activities' on his Day Planning List. **ACHIEVED^{P,M}**
Planning activities are all activities on his list that are not 'scheduled appointments.'				
Part B				
-2	**-1**	**0**	**+1**	**+2**
When given 2 scheduled activities on his phone calendar and four circled 'planning activities' on his Day Planning List:				
*P3 will enter 0 planning activities into his phone calendar at a reasonable time (not overlapping with schedule appointments).	P3 will enter 0 planning activities into his phone calendar at a reasonable time (not overlapping with schedule appointments).	P3 will enter 0 planning activities into his phone calendar at a reasonable time (not overlapping with schedule appointments).	P3 will enter 0 planning activities into his phone calendar at a reasonable time (not overlapping with schedule appointments). **ACHIEVED^{M}**	P3 will enter 0 planning activities into his phone calendar at a reasonable time (not overlapping with schedule appointments). **ACHIEVED^{P}**

Table 8D. Lab Goal 4 (Initiation) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Following audible + visual phone alarms (linked to four simple, 1-step tasks; 30 minutes following the creation of the alarms):				
P3 will initiate 0 tasks within 15 seconds of alarm.	*P3 will initiate 1 task within 15 seconds of alarm.	P3 will initiate 2 tasks within 15 seconds of alarm.	P3 will initiate 3 tasks within 15 seconds of alarm. **ACHIEVED^{M}**	P3 will initiate 4 tasks within 15 seconds of alarm. **ACHIEVED^{P}**

Table 8E. Lab Goal 5 (Texting) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Part A: Texting-Composing/Sending				
When given 2 research team members' numbers, and a topic of discussion (e.g., social greeting, inviting someone to a show, confirming meeting place and time for an appointment, etc.).				
*P3 will compose and send 0 text messages.	P will send 1 message that is blank/indecipherable, and will not compose/send the other message.	P3 will compose and send 1 clear message.	P will send 1 clear message, and will send another message that is blank/indecipherable.	P3 will compose and send 2 clear messages. **ACHIEVED^{P,M}**
*A clear message indicates a text that is 1) not a blank/empty (i.e. no text whatsoever), and 2) it is decipherable enough to derive meaning. Grammar and syntax are not necessarily perfect, but word order and spelling need to be adequate to derive meaning.				
Part B: Texting-Replying				
-2	**-1**	**0**	**+1**	**+2**
When 2 research team members text P3:				
P3 will send 0 replies to both text messages.	P will send 1 reply that is blank/indecipherable, and will not reply to the other text message. **ACHIEVED^{P}**	*P3 will send a clear reply to 1 of 2 text messages.	P will send 1 clear reply, and will send another reply that is blank/indecipherable. **ACHIEVED^{M}**	P3 will send a clear reply to 2 text messages.

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

Table 8F. Home Goal 1 (Note Organization) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

-2	-1	0	+1	+2
At the end of each week:				
*None of his notes will be entered in Google Keep App; he continued to use his current note taking system (multiple sticky notes, lists in multiple places, etc.). **ACHIEVED[P,M]**	Some of his notes will be entered in Google Keep App, with majority of his notes existing outside the app (sticky notes, etc.).	Half of his notes will be entered in Google Keep App, with half of his notes existing outside the app (sticky notes, etc.).	The majority of his notes will be entered in Google Keep App, with only some of his notes existing outside the app (sticky notes, etc.).	All of his notes will be entered in Google Keep App, with none of his notes existing outside the app (sticky notes, etc.).

* = Baseline Score [P] = Post-treatment, [M] = Maintenance [NB]= No Baseline Score

Table 8G. Home Goal 2 (Scheduling his Week) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Prior to the start of each week:				
-2	**-1**	**0**	**+1**	**+2**
*P3 will accurately schedule 0-19% appointments into his phone calendar.	P3 will accurately schedule 20-39% of appointments into his phone calendar.	P3 will accurately schedule 40-59% of appointments into his phone calendar. **ACHIEVED[P]**	P3 will accurately schedule 60-79% of appointments into his phone calendar.	P3 will accurately schedule 80-100% of appointments in his phone calendar.

* = Baseline Score [P] = Post-treatment, [M] = Maintenance [NB]= No Baseline Score

Table 8H. Home Goal 3 (Planning his Day) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Following daily alarm to schedule his day				
On his phone calendar, P3 will schedule at least 1 'planning activity' from his Day Planning List 0 days per week.	On his phone calendar, P3 will schedule at least 1 'planning activity' from his Day Planning List 1-2 days per week.	On his phone calendar, P3 will schedule at least 1 'planning activity' from his Day Planning List 3-4 days per week. **ACHIEVED^{M}**	*On his phone calendar, P3 will schedule at least 1 'planning activity' from his Day Planning List 5-6 days per week. **ACHIEVED^{P}**	On his phone calendar, P3 will schedule at least 1 'planning activity' from his Day Planning List 7 days per week.
"Use" of the Day Planning List is defined as circling at least 1 item on his Day Planning List **OR writing at least 1 event under the 'other' category.*				

Table 8I. Home Goal 4 (Initiation) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Following audible + visual phone alarms for a week of scheduled appointments:				
-2	**-1**	**0**	**+1**	**+2**
P3 will not initiate getting ready. He will rely on his current system, which includes his spouse cueing him to initiate.	P3 will initiate getting ready some of the time, but will require his spouse to cue him the majority of the time.	*P3 will initiate getting ready half the time, but will require his spouse to cue him the other half of the time.	P3 will initiate getting ready the majority of the time, but his spouse will cue him some of the time. **ACHIEVED^{P,M}**	P3 will initiate getting ready all the time, and his spouse did not cue him to get ready.

Table 8J. Home Goal 5 (Texting) for P3 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Goal: I want to learn how to text my friends and family.				
*P3 will not attempt to text at all during the week.	P3 will need help all the time to compose and send messages.	P3 will need help most of the time to compose and send messages. **ACHIEVED[M]**	P3 will need help some of the time to compose and send messages.	P3 will need help none of the time to compose and send messages. **ACHIEVED[P,]**

* = Baseline Score [P] = Post-treatment, [M] = Maintenance [NB]= No Baseline Score

GAS and Goal Attainment. See Figures 20-24 to track P3's GAS goal attainment across the study.

Lab Goals. From baseline to the maintenance period, P3 improved in 7/7 of his Lab Goals. P3's baseline goal attainment was *much less than expected* (-2) for 4 goals, *less than expected* (-1) for 1 goal, *expected* (0) for 1 goal, and *more than expected* for 1 goal. At post-treatment, P3 achieved +2 for 5 goals, +1 for 1 goal and -1 for 1 goal. At maintenance, P2 achieved +2 for 2 goals, and +1 for 5 goals. He did not score below baseline or expected goal achievement at maintenance for any goals. From post-treatment to maintenance, he maintained or improved his goal attainment for 3 and 1 goals, respectively, and achieved a slightly lower level of goal attainment for 3 goals.

Home Goals. At maintenance, P3 improved in 2/5 of his Home Goals. For 2 of the 3 goals that did not reflect improvement, there were extraneous factors: maintenance data were not collected or initial baseline goal attainment was already *more than expected* (+1). P3's baseline goal attainment was *much less than expected* (-2) for 3 goals, *less than expected* (-1) for 0 goals, *expected* (0) for 1 goal, and *more than expected* (+1) for 1 goal. At the post-treatment period, P3 achieved +2 for 1 goal, +1 for 2 goals, 0 for 1 goal, -1 for 0 goals, and -2 for 1 goal. At 1-month

maintenance, P3 achieved +2 for 0 goals, +1 for 2 goals, 0 for 1 goal, -1 for 0 goals and -2 for 1 goal. From post-treatment to maintenance, he maintained his goal attainment for 2 goals, improved in 0 goals, and achieved a slightly lower level of goal attainment for 2 goals. Goal attainment for Home Goal 2 was unable to be determined as maintenance data were not available.

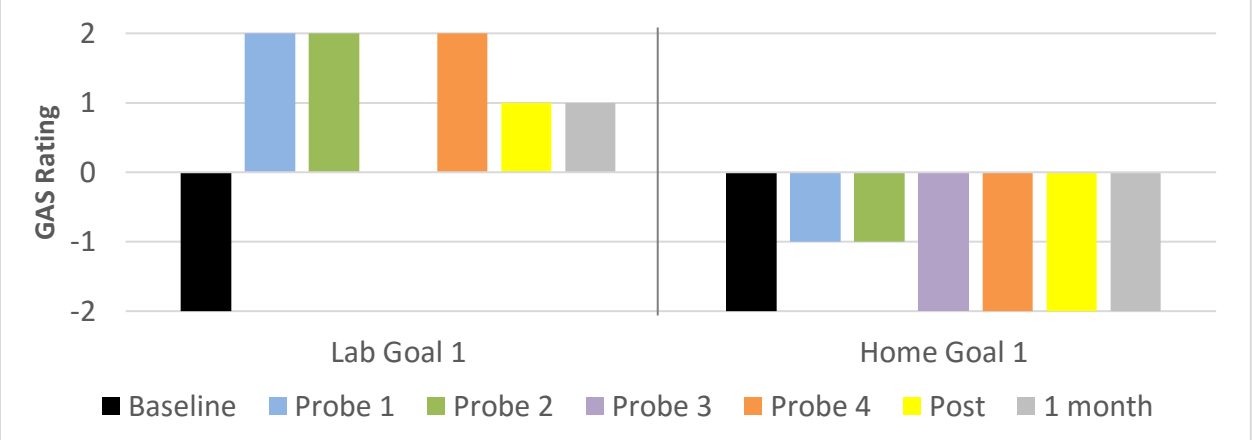


Figure 20. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 1 (Note Organization) for P3.

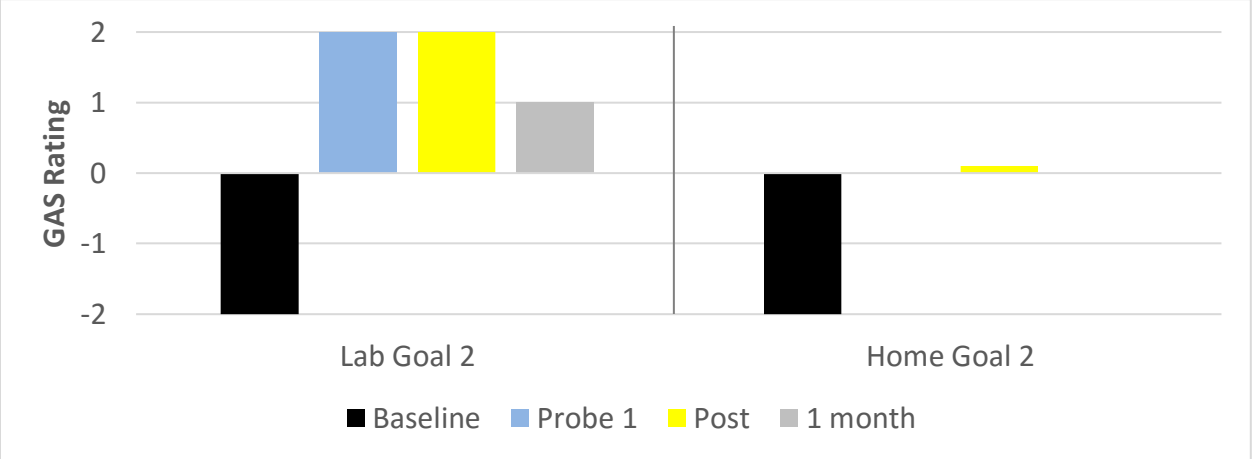


Figure 21. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 2 (Scheduling) for P3.

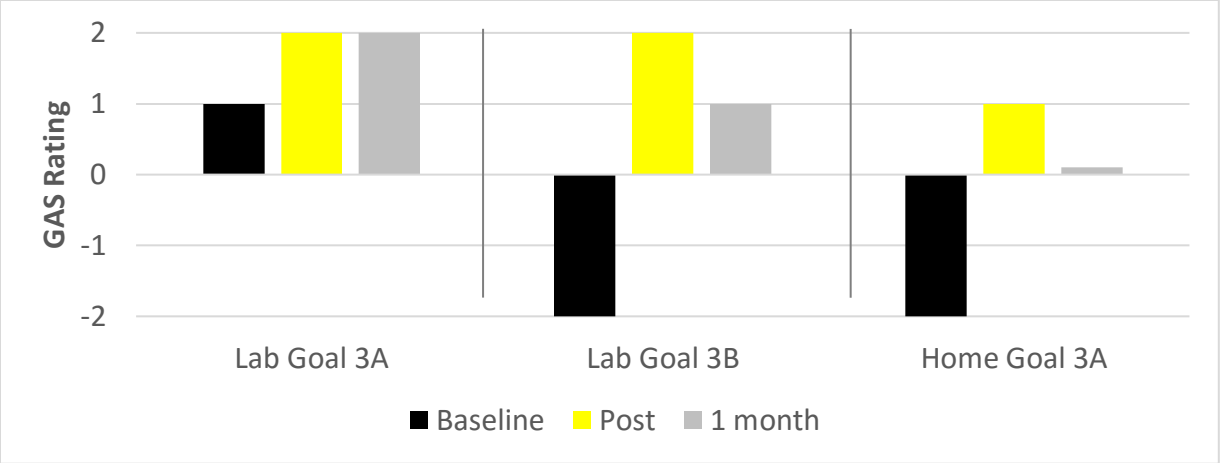


Figure 22. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 3 (Planning his Day) for P3.

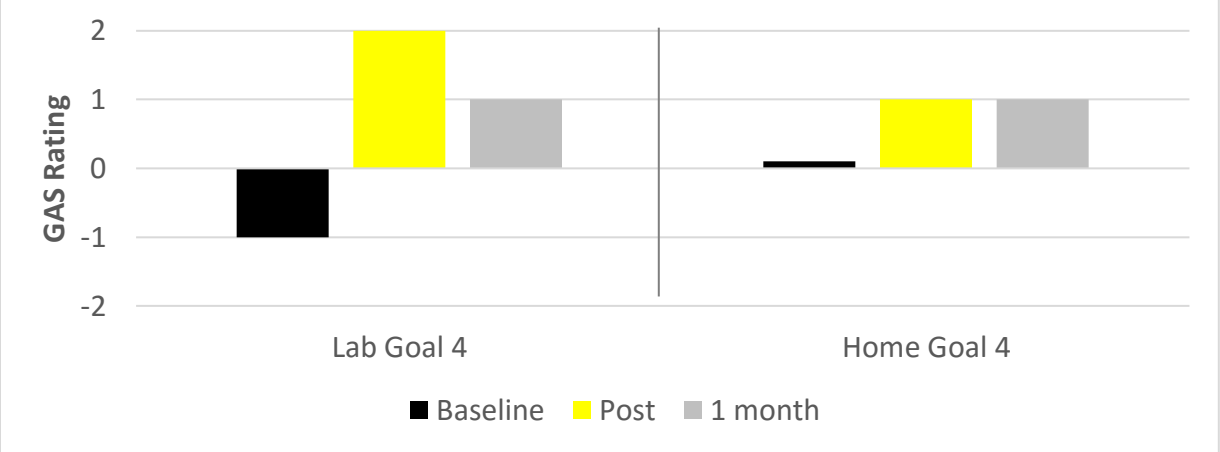


Figure 23. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 4 (Initiation) for P3.

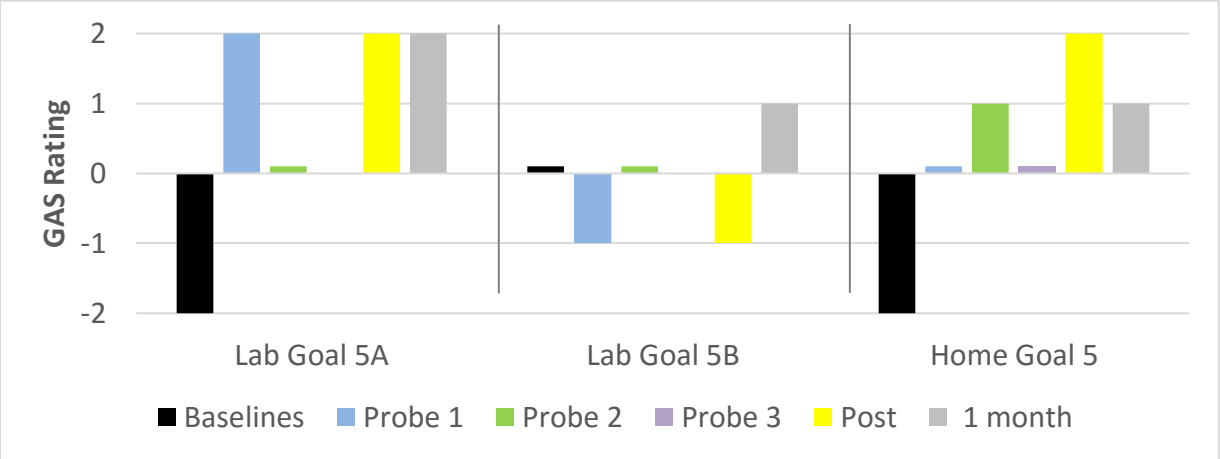


Figure 24. Goal Attainment Scale (GAS) ratings for Lab and Home Goal 5 (Texting) for P3.

T-scores were calculated for P3's Lab and Home Goals when baseline scores were consistent across goals (e.g., all baseline scores equaled -2). Goals were then collectively aggregated across and between goal type (Lab and Home) and baseline score (-2, -1 and 0). *T*-scores were not calculated for goals with a baseline score of 1 or 2. On average, P2's *T*-scores improved for Home Goals and Lab Goals when baseline goal attainment scores were -2. Similar *T*-score changes were seen for Lab Goals at the -1 baseline goal attainment level, with less marked improvement at the 0 goal attainment level. In general, Lab Goals had greater changes in *T*-scores across baseline goal attainment level than Home Goals. When all Lab Goals and Home Goals with were measured collectively, an aggregated *T*-score was 30.7 (below expected outcomes) at baseline, 66.8 (above expected outcomes) at post-treatment, and 63.8 (above expected outcomes) at maintenance per guidelines proposed by Grant et al. (2012), with the expected outcome range equaling 40-60. See Figure 25 to view P3's *T*-scores at baseline, post-treatment and baseline phases across the study.

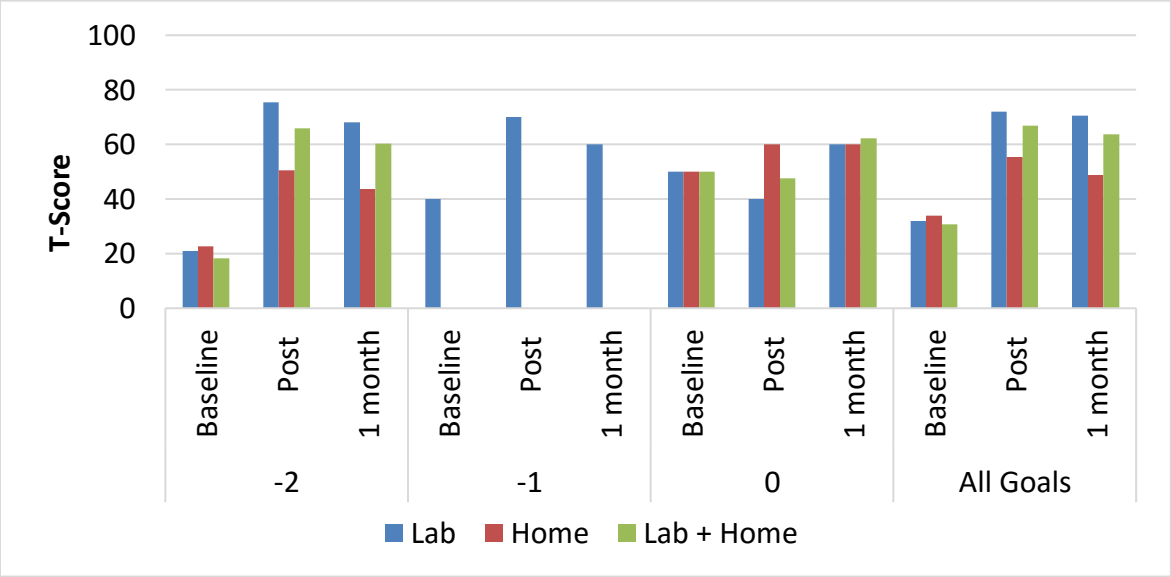


Figure 25. T-scores reflecting aggregated Lab and Home Goals for P3.

Descriptive measures.

Quality of Life Questionnaires. On the PDQ-8, P3 reported his level of functioning to be similar from baseline to post-treatment, with a slightly poorer score during the maintenance phase. P3 also maintained borderline depression throughout the study, as measured by the BDI-II. P3 also reported relatively steady scores on the BRIEF-A Self Report, with most improvement in the cognitive indexes of *initiation, working memory*, and *task monitoring.* His spouse reported slight improvements immediately post-treatment and at the one-month maintenance phase, with the most improvement in the same cognitive indexes in which P3 reported improvements. See Appendix G to view P3's BRIEF-A Report Forms. P3 had fewer concerns regarding his cognitive abilities per the PROMIS Applied Cognition Form at post-treatment and maintenance assessments. A small improvement was also seen on P3's PROMIS-Satisfaction Questionnaire, particularly during the one-month maintenance period.

Compensatory Techniques Inventory (Appendix H).

Independence Screen. From baseline to the maintenance period, P3's self-perceived independence increased in 3/9 Life Tasks (e.g., social arrangements, cleaning, and laundry), and slightly worsened in 3/9 Life Tasks (e.g., help making appointments, shopping, and driving*)*. The remaining 3 areas were stable. P3's spouse also noted more independence in 2/9 tasks (e.g., managing finances and social arrangements), but had reduced independence in 4/9 areas (e.g., making appointments, shopping, driving, and cleaning). The remaining 3 areas were stable. At maintenance, P3 and his spouse both rated him as completely independent in social arrangements, cleaning, and personal care.

Functional Cognition Screen. Between baseline and the maintenance period, P3 reported improvement on 4/11 cognitive issues (*don't know the date, miss appointments, double schedule,*

and *start but don't finish tasks),* with decline in 2/11 areas (*forget to complete tasks* and *cannot stay forced and return to tasks when interrupted*). The remaining 3 areas reflected stability. His spouse also reported improvement form post-treatment to maintenance in 4/11 cognitive issues (*miss appointments, forget to complete tasks, have trouble organizing days and tasks,* and *start but don't finish tasks),* and maintenance of skill in 4/11 areas. Of the 2/3 areas with a reported decline, (*forget what I did yesterday*), P3 and his spouse's scores were identical (*lose keys, double schedule*). P3's spouse also reported that *missing appointments* was not an issue at maintenance.

Compensation Use. At maintenance, P3's spouse reported P3 was using a greater number of scheduling external aids than at baseline, including a wall calendar, a personal pocket calendar and an electronic scheduler. P3 would transfer appointments from his pocket calendar to his cellphone on a weekly basis. P3 also was using a daily planning list/checklist to plan his days. Though he received training in a cellphone note-taking application, P3 shifted to take handwritten notes in a notebook, of which he reported to be useful. P3 used several other external aids during this study and can be reviewed in Appendix H.

Interview. The following statements reflected in Table 9 were made by P3 and his spouse regarding how they perceived the study and its impact on their lives.

Table 9. Interview Comments from P3 and P3 Spouse.

Statements from P3 and P3's Spouse	
Person	**Comments**
P3	***Post-Treatment*: *"I think this study helped quite a bit. Overall, I am better with my cellphone than before, and I use it more."*** *Note Taking*. P3 reported that he seldom takes notes on the *Google Keep* app to organize his notes because it is just not as natural and takes more mental effort. He also made this comment regarding this goal: "I just don't have as many notes to take as I used to. I have to come to terms with that and my new reality… This study has made me realize this goal wasn't as important as I thought it was; it's definitely not as important as it used to be." *Scheduling*. P3 felt he was better with scheduling than before the study and stated that he is "more aware when to leave places." He stated that he found the alarms to be helpful when he heard them go off, but that his spouse continues to remind him when to leave most of the time. He stated he used the daily planning list nearly every day. *Texting*. "It's been going good, and people have been surprised." ***Maintenance:*** P3 did not report any significant changes at maintenance. He expressed that though he doesn't take a lot of notes, the ones he does take, he writes down in a notepad. He also reported that his spouse alerts him to get ready more frequently than prior to the study, and stated, "I think I would miss appointments if [my spouse] didn't remind me." ***Remaining Concerns:*** P3 also stated he only heard some of the alarms on his phone to alert him to his appointments. Additionally, P3 reported his memory was declining, causing him to forget things more often and creating additional worry.
Spouse	***Post-Treatment:*** "***I'm very happy. This study has taught me more than I think it taught [P3]."*** *Note Taking*. "I've started to use this application to help me, but [P3] doesn't really use it." *Scheduling*. P3's spouse stated that the electronic scheduling system P3 learned in the study "lessens the frustration about communicating" and "taught me a lot about scheduling." She also stated that she realized they need to use the tools to help her and her spouse cope with PD. P3's spouse also stated that they used the daily planning list and added additional categories, such as a meal list. She also stated that "P3 uses [the list] the night before to plan his day, and he uses it all the time." *Texting:* "He's learned so much, though sometimes he has a problem replying."

	Maintenance: "***I found it really helpful, more so than [P3]. I learned that the more visual the better; I hadn't realized that until we started the study."*** P3's spouse also stated that she hadn't seen any big changes or a downfall since post-treatment in P3's abilities trained in the study. *Scheduling*: "He will do some things himself, we sometimes do it together, and he uses his voice to make the appointments. The big [wall] calendar helps him be more grounded in time." P3's spouse also stated that P3 continues to use daily planning lists to plan out each of his days. *Texting:* "What I tell [P3] is that he doesn't have to reply, just send me a new text. He can read the text, and he can reply by sending a new text, because he's really good at that. It's much easier that way." ***Remaining concerns***: P3's spouse echoed P3's concern about his declining memory performance. She also was concerned about P3's overall declining ambulatory abilities and multiple falls. She additionally reported she had to take more notes and leave more written reminders for P3 to help him remember to complete daily tasks.

Control Goal. As anticipated, P3's performance on the control goal remained relatively stable across each assessment period on the higher level 'logic puzzle.' His BL score (5/20) did not change appreciably during post-treatment (5/20) or at maintenance (7/20).

Summary. P3 demonstrated marked improvement across his Lab and Home Goals, and met or exceeded expectations at the 1-month maintenance period for all but one goal. The goal in which he did not reach expectations was heavily dependent on P3's completion of Home Goal tasks each week, not his ability to correctly use the external aid. P3 reported functional improvements in his interview and mild improvements on his quality of life questionnaires; his spouse reported similar observations and discovered additional tools and compensations to help P3 organize his days. His use of and efficiency in using his external aids (cellphone calendar and texting applications and daily list) improved, and he was working more closely with his spouse to ensure his schedule was correct.

Group GAS Scores

Goals from all participants with a baseline score of -2 were collectively analyzed to document the "group's" goal attainment between baseline, post-intervention and at the 1-month maintenance assessment (see Figure 26). All GAS T-Scores significantly improved from baseline to post-treatment and maintenance, with T-scores changing from below the expected outcome range (with the outcome range equaling 40-60) to meet or exceed the expected outcome range (Grant et al., 2010). Please note that Home Goal data for P1 is not incorporated into aggregate T-scores in Figure 26, as no baseline scores were collected for P1's Home Goals.

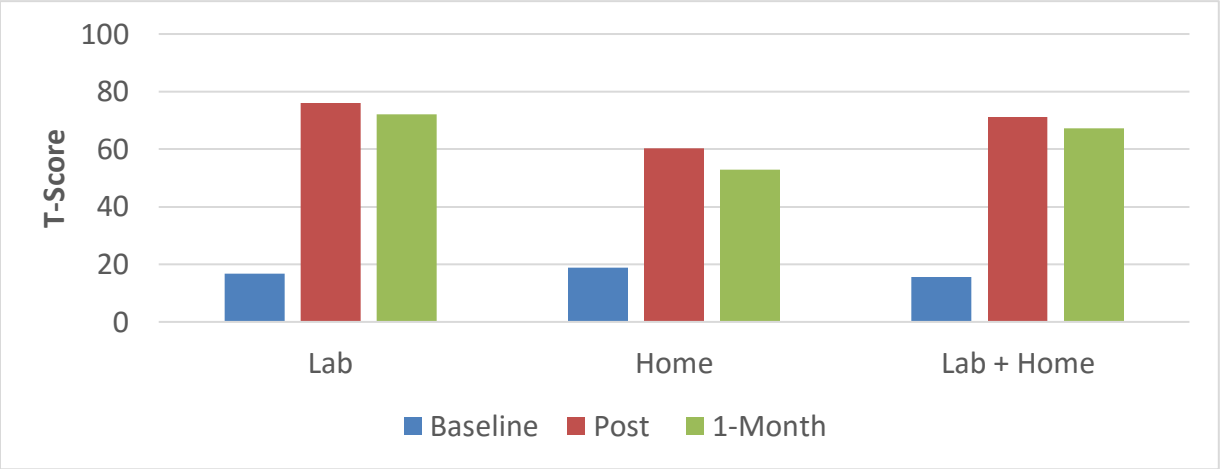


Figure 26. T-scores reflecting aggregated Lab and Home Goals for P1, P2 and P3.

Discussion

This case series is the first study that explored an external aids treatment program for individuals with cognitive deficits secondary to idiopathic Parkinson's disease. It presents descriptive and quantitative data from three individuals who underwent an 8-week external aids treatment program to help them achieve their personalized goals measured by Goal Attainment Scaling. Findings from this study help to address the current void in the literature regarding cognitive rehabilitation for Parkinson's disease. The study's most robust finding is that all three

participants improved in the majority of their personalized goals, as measured by the primary outcome and descriptive measures.

Primary Outcome Measures

The primary outcome measure was Goal Attainment Scaling (GAS), which is a systematic, objective, and quantifiable method used to define and measure progress of functional goals that are meaningful to the client. Goals were co-constructed with the study's investigator, and GAS levels were reviewed by at least one additional investigator to verify that each level on the scale was equidistant, non-overlapping, measurable, and realistic. GAS scores were determined by two independent raters who viewed videotaped assessments and probes, and assigned a GAS score for each Lab and Home Goal across assessment periods and probes.

All three participants improved in the majority of their GAS Lab and Home goals from baseline to immediately post-training (Research Question 1) and at a 1-month maintenance assessment (Research Question 2). Participants 1 and 2 demonstrated relatively stable goal attainment from post-treatment to the maintenance period; however, P3 demonstrated less stability, maintaining or improving his GAS score for approximately half his goals, with the remaining half indicating decreased goal attainment. Though P3 had less stability from post-treatment to maintenance, his performance at the 1-month post period still exceeded his baseline level of functioning for all but one Home Goal. P3 had more significant memory deficits than Participants 1 or 2 at baseline and had sustained multiple falls during treatment, which could have likely influenced his ability to maintain newly learned skills during the 1-month follow-up assessment.

Goal attainment was also reflected by the T-score analysis. While the specific use and interpretation of T-scores is debated (Krasny-Pacini et al., 2013), it remains the most frequently

used method to normalize GAS scores to facilitate comparisons across participants. GAS T-Scores significantly improved from baseline to post-treatment and maintenance, with T-scores changing from below to above the expected outcome range (with the expected outcome range equaling 40 – 60; Grant et al., 2010). All participants scored within the expected outcome range or higher across their GAS goals, regardless of baseline GAS score.

Similarities across the participant's co-constructed GAS goals were observed. All participants formulated a goal relevant to scheduling (e.g., scheduling their weeks via cellphone calendars) and organization (e.g., P1 = being prepared prior to leaving, P2 = desk organization and medication organization, and P3 = note organization). Within these two areas, all participants improved their GAS scores for both Lab and Home Goals from baseline to post-treatment and maintenance assessments (Research Goal 1). They also showed relative stability in their goal attainment from post-treatment to maintenance for both Lab and Home Goals (Research Goal 2). Future research regarding scheduling and organization may be areas of further investigation to assess the effectiveness of training these areas in a larger representative sample.

Descriptive measures

Participant 1 showed progress on numerous descriptive measures. He indicated improved functioning and well-being on the PDQ-8, and shifted from mild depression to no depression according to the BDI-II. Additionally, P1 demonstrated marked improvement on the BRIEF-A, which is an ecologically sensitive measure of executive functions, particularly in the areas of initiation, planning and organizing. These cognitive processes reflect the focus of the treatment for P1's self-selected goals. Small improvements were also seen in the PROMIS-Satisfaction Questionnaire. However, while P1 expressed fewer concerns on the PROMIS Applied Cognition

questionnaire immediately after treatment, his concerns rose beyond the baseline mark during the maintenance phase. These concerns were consistent with P1's acute awareness and apprehension of the changes to his cognition from Parkinson's disease.

Participant 2 also showed improvement on several descriptive measures. Her depression scores reduced, and she indicated increased satisfaction with social roles via the PROMIS questionnaire, particularly immediately post-treatment. Additionally, she expressed fewer concerns on the PROMIS- Applied Cognition questionnaire following treatment, and this perspective maintained at the one-month follow-up assessment. P2 evidenced small improvements on the BRIEF-A executive function questionnaire; these improvements were also reflected by the spouse's report. However, while small improvements in functioning and well-being were captured by the Parkinson's Disease Questionnaire (PDQ-8) immediately after treatment, P2's scores worsened beyond baseline during the maintenance phase, suggesting a more negative view of her overall health status and functioning as related to her Parkinson's disease.

Similar to Participant 2, Participant 3 also expressed a more negative view of functioning and well-being per the PDQ-8 during the one-month follow-up. It is possible that the questionnaire was capturing motor-related concerns for these participants as half of the items relate directly or indirectly to motor function (e.g., difficulty getting around, difficulty dressing oneself, painful muscle cramps, embarrassed in public because of PD). Alternatively, the concern reflected on the PDQ-8 might suggest a dampened view of overall psychological and cognitive well-being (level of depression, close personal relationships, ability to concentrate, ability to communicate). However, P3 had a slight reduction in concerns about cognition and more satisfaction with social participation via the PROMIS questionnaires, particularly during the one-

month maintenance period, and his borderline depression scores were maintained throughout study period. This pattern suggests that the concerns reflected on the PDQ-8 may have been rooted in overall motoric functioning, consistent with the increased motor instability and falls experienced by P3. Finally, Participant 3 had a relatively steady perception of his executive functions per the BRIEF-A throughout the study. In contrast, his spouse reported small improvements in P3's executive functions immediately post-treatment, and pronounced improvement at the one-month follow-up. It is not unusual for significant others to have a more positive view of overall level of cognitive functioning experienced by the person with PD (Sitek, Soltan, Wieczorek, Robowski, & Slawek, 2011), particularly with respect to executive functions (Horwitz & Spencer, 2014)

In summary, all three participants reported improved satisfaction with life participation, and two of three participants had improved depression scores at post-treatment and maintenance. All had improved self-perceived functioning and well-being immediately following the study, but this improvement was only maintained for one participant at the one-month follow-up assessment. All three participants demonstrated improvement on the BRIEF-A per self- or informant-report. Additionally, scores on the Compensatory Technique Inventory revealed that all three participants and their spouses perceived themselves or their respective participant to have 1) improved or maintained their independence in completing the majority of life tasks from baseline to maintenance, 2) reduced difficulty with the majority of listed cognitive issues (especially if the cognitive difficulties were related to the cognitive areas in which their external aid(s) compensated), and 3) increased the number of external aids used and the frequency with which external aids were used.

Control Goal

A high-level cognitive puzzle served as a control measure; a different version with equivalent difficulty levels was used for each assessment. All three participants maintained a relatively stable score across the study. This denotes experimental control and provides evidence that the external aids training was responsible for the improvement in the primary outcome and descriptive measures across the participants, versus influence from extraneous factors.

The original intention was to formulate personally relevant control goals as measured by GAS. However, it was difficult to create goals that would not experience "contamination" from the training of the external aids, as this training involved aspects of executive functions, attention and memory, among other cognitive domains, as related to ADLs. The deduction puzzles tapped into overall problem solving and cognitive function, but was removed from the day-to-day tasks and cognitive challenges of each participant.

Semi-structured Interviews

One important finding from the semi-structured interviews was that all three participants reported they could use their tools more efficiently and frequently at post-treatment and maintenance than at baseline. For example, they all increased the time they spent scheduling each week, thus spending more time using their external scheduling aids. Furthermore, at the maintenance assessment, all participants used additional scheduling aids paired with the trained external aid to facilitate their ability to arrive to appointments on time (e.g., cellphone calendar application and a wall calendar). Each of the spouses also reported more awareness of daily schedules, due to increased time devoted to scheduling and the use of their external aids. There also was a trend across participants of reduced anxiety to use their tools following external aid training.

None of the participants or spouses reported any significant changes or declines from post-treatment to maintenance periods, with the exception that P1 had reportedly not used his iPhone for scheduling during that period. Additional commonalities included: 1) all three participants were arriving on time to their appointments/missing fewer appointments, 2) all participants and their spouses saw some degree of functional impact in their daily lives related to the goals targeted in therapy, and 3) all participants (and their spouses) had increased concerns about their (or their respective participant's) declining cognitive functioning.

Interpretation of Treatment Effects

All three participants demonstrated considerable improvement, as measured by the primary outcome and descriptive measures, after a relatively short treatment duration. The basis for this improvement is undoubtedly multifactorial, but is likely influenced by three primary factors: (1) a theoretically motivated focus on external cuing, (2) well-documented, systematic approach to instruction, and (3) the personalization of goals.

Internal vs external cuing. Therapy approaches used to train cognitive domains and daily tasks can take many forms, such as (1) an impairment based approach in which the specific cognitive constructs are targeted, 2) a compensatory, internal cueing approach grounded in metacognitive strategies, and 3) a compensatory, external cueing approach. Recent research has found that reversal of cognitive impairment is unlikely for individuals presenting with PD despite impairment-based treatments (Petrelli et al., 2014). On the contrary, there is strong evidence to support the use of external aids for memory impairment and executive dysfunctions for individuals with acquired brain injury (Boelen et al., 2011; Sohlberg et al., 2007). These findings have also been replicated in the PD literature, with participants demonstrating improved

performance during ADLs and sustained attention tasks when provided external versus internal cues (Cassimatis et al., 2016; Cools et al., 2010; Spencer, 2007).

In the present study, each participant found that the external structure, whether it be calendar alerts, a daily checklist, or labeled categories on a desktop, helped them achieve their daily goals better than prior to the study (when they were not using any external aid(s) for their goals). P2 also specifically reported that her personal experience with previous impairment-based cognitive therapies was ineffective, and did not impact her daily functioning or quality of life. These therapies focused on impairment-based tasks that stressed working memory functions, such as repeating strings of numbers in reverse order. She also reported using some internal cueing methods, such as trying to remember to put her keys and wallet in the same spot each time she set them down. She concluded that these therapies did not help her to find her items and that her memory did not improve as a result of these internally cued-based therapies. However, after completing the current study, P2 reported a perceivable improvement during her daily functioning when utilizing her external aids. P1 and P3 also reported similar findings, including more frequent on-time arrival to appointments when using external aids versus relying on internal cues (e.g., telling themselves to remember to get ready for appointments). This study further supports recommendations made by Cassimatis et al. (2016) which encourage clinicians to incorporate external cues into therapy to ameliorate difficulties encountered by individuals with PD during daily tasks.

Systematic instruction. External cueing has emerging evidence to be an effective approach for people with PD. To increase the likelihood of success when using external aids, systematic instructional practices (e.g., errorless learning, spaced retrieval, etc.) are recommended, as they have been found to help individuals with memory and executive function

impairments effectively acquire and maintain the ability to use external aids (Bowman et al., 2010; Ehlhardt et al., 2008; M. M. Sohlberg & L. S. Turkstra, 2011). Key systematic instructional principles used in this study to train external aids included errorless learning, spaced retrieval, task analysis, systematic fading of cues, multiple exemplars, verbalization to promote effortful processing, sufficient practice, and ecological targets.

Task analysis was consistently utilized across participants and goals, especially when training multi-step procedures (e.g., texting, scheduling appointments on a cellphone calendar application, organizing a desk, etc.). Independence at a given level needed to be consistently demonstrated prior to linking subsequent steps. Errorless learning and spaced retrieval were incorporated to ensure user acquisition. If participants had difficulty starting a multi-step procedure (e.g., scheduling and appointment) following training, once they initiated the first step, they frequently completed the rest of the sequence quickly and without noticeable effort, as the participants were likely (at that point) utilizing procedural memory resources. Challenges to the implementation of task analysis included troubleshooting technology, including determining the steps needed to navigate to the correct page and resume the intended multi-step sequence if the cellphone screen changed unexpectedly. A yellow visual anchor was attached to P3's cellphone's home button as an external cue to remind him to hit his home button if a troubleshooting error occurred.

While each participant had an equal number of therapy sessions, the participants received an average of four sessions in which one goal was targeted. Ideally, participants would have received a least six sessions per goal as recommended by Ehlhardt et al. (2008) to improve learning outcomes; however, participants in the current study were able to demonstrate improvement in their goals with slightly less than the recommended number of sessions. This is

likely attributed to the use of several systematic instructional principles utilized each session to train each external aid, including errorless learning, multiple exemplars, repetition, verbalization of each step, and fading of cues, to facilitated acquisition, improvement, and maintenance of their goal achievement.

Based on the results of this study, it appears that the systematic instructional principles were effectively implemented to train use of external aids. Combining multiple instructional principles is recommended, as it has shown to enhance learner outcomes over studies that used only one instructional method (Ehlhardt et al., 2008).

Personalized goals. The extant literature regarding cognitive therapy for individuals with PD is solely focused on impairment-based treatments via paper-pencil tasks, computer programs or cognitively stimulating games; improvement is generally measured with formal neuropsychological assessment measures, and rarely on quality of life or personalized goals (Cerasa et al., 2014; Edwards et al., 2013; Farzana et al., 2015; Paris et al., 2011; Pena et al., 2014; Petrelli et al., 2014; Sammer et al., 2006). No studies of people with PD to date have used personalized goals as their primary outcome measure; daily functioning or quality of life measures, if used at all, were secondary or generalization measures. For example, P2's previous cognitive therapy (mentioned above) focused on improving her memory impairment; however, she continued to forget appointments and did not perceive any notable change in her memory following impairment-based treatment. This study is the first to use personalized goals via GAS as a primary outcome measure for this population to assess functional impact during daily tasks using external aids. We found that each participant experienced some degree of improved daily functioning related to their co-constructed goals following external aid training, as reflected in primary outcome and descriptive measures.

Challenges in creating personalized goals included the initial time-consuming commitment in generating the GAS scales, as also noted by Grant and Ponsford (2014). Our current study devoted the first assessment period and the first week of treatment to define each participant's external aids and create GAS goals that were relevant, important and measureable for each participant. Generally, less time is devoted to creating goals in clinical setting. Furthermore, there were relatively few GAS examples in which to guide goal creation, which also likely increased the time to generate GAS goals that met all the recommended criteria (Bovend'Eerdt et al., 2009).

Based on the results of this study and the level of perceived benefit reported by the participants, the use of personalized goals in cognitive therapy is recommended to target functional tasks. Specifically, co-construction of GAS goals is a useful way to define realistic and achievable goals. However, the time commitment to write GAS goals that meet recommended criteria is considerable (Bovend'Eerdt et al., 2009).

Limitations and Future Directions

This case series study provides a basis for which to further investigate the use of external aids to help individuals with PD attain their goals. An obvious limitation, however, is the small sample of only three individuals. Thus, we do not know how these findings will generalize to a broader sample of individuals with PD, particularly those with more severe cognitive or motoric involvement.

While baseline goal attainment for all participants' Lab and Home Goals (with the exception of P1's Home Goals) was measured prior to the initiation of treatment, as recommended by A. Krasny-Pacini et al. (2016), only P1's Lab Goals were revised after baseline testing to ensure his true baseline performance reflected a -2 level of goal attainment on his GAS

scales. This made it difficult to directly compare goal attainment for P2 and P3s' goals and across all three participants, collectively. Another challenge was the Home Goal data collection process, which relied on the participant's spouses to take data. While the majority of spouses were able to take and return data, baseline data was not returned for P1 and for some of P2 baseline goals. This made it difficult to truly determine the effectiveness of the external aids treatment program for those goals. As mentioned previously, another limitation was the control goal was not written as a GAS goal, making it difficult to directly compare control goal performance to Lab and Home goals.

Encouraged by the findings to date, we believe this line of external aids cognitive therapy for individuals with PD warrants further research and development. There is a need for replication of the present study, as well as implementation of well-controlled, randomized studies with participants with varied cognitive/motor profiles and appropriate control groups. Though outcome measures were collected throughout the study, the maintenance period was only one month following treatment. This is a relatively short amount of time and it is difficult to know the long term effects of the external aid training program. A longer maintenance period, such as three or six months, should be considered to assess maintenance of learned skills and impact on quality of life, in the context of a degenerative disease.

As GAS scheduling and organization goals were common across participants in this study, further evaluation may include a more in-depth study of these areas, potentially exploring the benefit of one external aid over the other (e.g., electronic versus paper-pencil calendars). Having common areas of focus may likely reduce the initial time-commitment to write GAS goals, and allow for further exploration of the multiple aspects incorporated within each goal (e.g., use, accuracy, and efficiency). Additionally, because all participants were using more than

the single external aid trained in the study to help manage their schedules, research looking at the benefit of combined external aids versus one external aid may help differentiate the benefits and drawbacks of using more than a single external aid for a goal.

To have consistent probes from baseline to maintenance assessments, GAS goals were created and external aids were given to participants prior to training. Just the presence of the external aid and their heightened awareness of their goals may have influenced their baseline performance. To provide increased experimental control, two baseline periods may be considered, including a baseline without external aids and a baseline in which the participants utilized their external aids. This may provide additional information about the benefit of external aids, even without treatment. Similarly, some participants demonstrated dramatic improvement in goal attainment following a few sessions. Future studies could explore the relationship between the duration of training and perceived benefit.

Additionally, future studies could explore internal versus external cueing methods and how each of these methods impacts level of GAS goal achievement. This type of study would provide information on which type of cueing was most effective for individuals with PD to achieve their personalized goals. Continued refinement of how to track goal attainment in the home setting may also help improve validity and feasibility for both spouses and researchers. Future research might also consider how to write GAS control goals to increase experimental control.

As discussed by Calleo et al. (2012), PD itself poses several inherent obstacles for success in terms of cognitive rehabilitation. Researchers will need to address these issues when developing future cognitive rehabilitation programs for patients with PD, including the heterogeneity of cognitive impairment, variability of functioning for patients with on/off

fluctuations, co-occurring depression and anxiety, the mobility issues that restrict access to therapy programs, and the optimal disease stage in which improvements in cognitive functioning would be most beneficial. However, the results of the current study, coupled with promising findings from research on external cuing in PD, fully justifies continued and enthusiastic research efforts in this area. Efficacious treatment programs could create positive and long-lasting benefits for people with PD by improving quality of life and potentially decreasing caregiver burden.

Appendices

Appendix A: GAS Formulas

Formula 1: Used to calculate T-scores for individual goals, multiple goals for 1 participant, or multiple goals across multiple participants.

$$GAS = 50 + \frac{10\Sigma(w_i x_i)}{\sqrt{((1-\rho)\Sigma w_i^2 + \rho(\Sigma w_i)^2)}}$$

w_i = weight of each goal (importance X difficulty)

x_i = goal attainment (-2 to +2)

p = expected correlation of goal scales (0.3)

(Kiresuk & Sherman, 1968)

Example of how to calculate formula 1 (Turner-Stokes, 2009).

Baseline: w_i = 6, 4, 2; x_i = -1, -1, -2, p = 0.3

Outcome: w_i = 6, 4, 2; x_i = +2, 0, -1, p = 0.3

$$\text{Overall Goal Attainment Score} = 50 + \frac{10\Sigma(W_i X_i)}{\sqrt{(0.7\Sigma W_i^2 + 0.3(\Sigma W_i)^2)}}$$

Starting with: $\sqrt{(0.7\Sigma W_i^2 + 0.3(\Sigma W_i)^2)}$ we have:

$$\sqrt{(0.7 \times (36+16+4) + 0.3 \times (12)^2)}$$

$$= \sqrt{(39.2 + 43.2)}$$
$$= 9.07$$

Then applying the full formula:

The baseline score is $50 + \frac{10(-14)}{9.07} = 50 + (-140/9.07)$
$= 50 - 15.4 = 34.6$

The outcome score is $50 + \frac{10(+10)}{9.07} = 50 + (100/9.07)$
$= 50 + 11.0 = 61.0$

The change in score, should one wish to measure it, is therefore 26.4

Without the goal weighting, the baseline outcome and change scores would be 31.7, 54.6 and 22.8, respectively

Appendix A Continued: GAS Formulas

Formula 2:

When all goals are equally weighted (w = 1), Formula 1 can be rewritten as:

$T = 50 + C(x_i)$

where C is a constant depends only on the number of scales on a follow-up guide:

Value of C	Number of scales
10.0	1
6.20	2
4.56	3
3.63	4
3.01	5

Example 1. When the attainment score for each of three goals is 0:
$x_i = 0$
$T = 50 + 4.56(0);\ T = 50$

Example 2. When the attainment scores for three goals are +2, −1, and +1, respectively,
$x_1 = +2;\ x_2 = -1;\ x_3 = +1$
$T = 50 + 4.56(+2);\ T = 59.12$

(Schlosser, 2004)

Appendix B: Guidelines for GAS Reliability and Validity in Research

(as found in A. Krasny-Pacini et al., 2016, pp. 160-165)

Table 1 GAS methodology quality appraisal for rehabilitation efficacy studies

Quality Appraisal Items	Item Description	Examples of Reported Criteria, Extracted From Rehabilitation Effectiveness Studies and/or Published Methods That Satisfy Criteria	Potential for Bias Arising From Failure to Report Criteria and/or Utility of Reporting the Criterion
Content validity			
Collaborative goal setting	The client/family is included in goal selection when possible and appropriate. If goals are therapist chosen, they rely on a comprehensive assessment (and when possible, a client/family interview), identifying key target domains for intervention.	"GAS was used to assess functional and participation changes from both a parent and therapist perspective."[51(p824)] "Using a semi-structured interview…3 performance goals were identified at baseline by parents and child with the research physical therapist. The same 3 goals were then structured for GAS through semi-structured interview and by collaboration between research therapist, parent and child."[52(p6)]	Collaborative goal setting allows evaluation of intervention efficacy for personally meaningful goals, rather than generic goals, and is a core component of GAS methodology. Involvement of the client in goal setting is considered to increase the likelihood that the intervention has direct impact on client's daily life.
Relevance/importance	GAS scales have been verified by an external judge to check for the relevance of chosen goals and to check if GAS levels represent clinically meaningful change.	In a study of infants with motor delays, Palisano[37] used a 5-point scale to assess the following: (1) importance of goals for motor development ranging from unimportant or inappropriate to important for development and function; and (2) extent each level represents an important progress based on the number of paired levels that represent important change (none to all 4 paired levels). Cardillo[53] proposed a 5-point scale ranging from 1 (no relevance) to 5 (total relevance).	If the target goal is unimportant to the client, irrelevant for function, or does not correspond to a clinically meaningful change, progress on the GAS scale has no clinical relevance. At the extreme, an intervention could be proven to be effective, by writing clinically and personally irrelevant goals, but showing statistically significant progress on the corresponding GAS scale.
ICF classification of goal types	GAS themes correspond to functional domains. Authors report the ICF domain the GAS relates to.	In a study of botulinum toxin effectiveness, Turner-Stokes et al[29] report exhaustively the types of goals for treatment, categorizing them into ICF domains (body function: 46 GAS, including 12 GAS on passive movement/range; activities and participation: 119 GAS, divided into upper-limb activities: 30 GAS; mobility: 11 GAS; self-care: 57 GAS; domestic and community: 21 GAS). Phillips et al[54(p540)] report precise examples of target goals in different ICF domains (eg, "driving for 40 minutes without feet going floppy"; "standing in supermarket queue for 3 minutes without support").	If GAS scales assess change in body structures (eg, range of motion, spasticity), the reader may wrongly conclude that the intervention had an impact on meaningful activity and participation because most readers associate GAS with functional daily life goals. It is therefore crucial that authors report the proportion of goals in each ICF domain, especially if some of the goals do not correspond to functional domains.

Appendix B Continued: Guidelines for GAS Reliability and Validity in Research

Quality Appraisal Items	Item Description	Examples of Reported Criteria, Extracted From Rehabilitation Effectiveness Studies and/or Published Methods That Satisfy Criteria	Potential for Bias Arising From Failure to Report Criteria and/or Utility of Reporting the Criterion
Specificity	GAS scales have been verified by an external judge to check for specificity to the aim of the intervention. If GAS is used as a generalization measure to untrained goals, GAS should be specific to the function the intervention is aiming to improve.	In an intervention for executive dysfunction in children,[55] a specific goal of intervention was to manage a cooking recipe unaided, which was trained on different recipes; a generalization goal was to be able to prepare a school bag, which was not trained (but stepwise processing taught was expected to generalize to this untrained goal). Although important to the children, goals (eg, have more friends) were not included because they were not specific to the aim of intervention, but they might have been used as control goals, not expected to be attained.	Goals that are relevant to the client, but unrelated to the specific intervention, are unlikely to show progress and may erroneously lead to the conclusion that the intervention is not effective (this is especially a risk in replication studies).
Reliability			
Reliability of scale construction			
Equidistance of levels	GAS scales have been verified by an external judge to check if difficulty from one level to the next is roughly equal.	Equidistance of GAS levels was assessed and compared statistically between 2 experimental groups using a 3-point scale by Ruble et al[27(p14)]: "1: None or only one of the descriptions are equilibrated appropriately in reference to the goal; 2: Two of the descriptions are equilibrated appropriately in reference to the goal; 3: All of the descriptions relative to the goal are equilibrated and scaled appropriately)."	If GAS scores are higher in the experimental conditions, one could argue that the intervals between each scaled description are unequal and favor the experimental group. This problem is particularly serious if parametric statistics and T scores are used.
Preintervention performance	Preintervention performance has been verified and corresponds to initial level described in the scale. Preintervention score is comparable across groups (same number of clients starting from −2 and −1).	"At first baseline, GAS were created based on parent's, teacher's and school assistant's concerns. After two months (second baseline), the paper versions of the scales were scored by parents, teachers and school assistants who were not aware that the intervention had not started yet. Their answers allowed readjustment of the scales, through the following rules: Scales that scored 0 were reformulated in order to have the pre-intervention level (measured at second baseline) corresponding to −1 by fixing more challenging 0, +1 and +2 scores. Scales scoring −2 or −1 were not reformulated. Scales scoring +1 or +2 pre-intervention were removed as the goal seemed attained without intervention or unreliably scored due to potential enthusiasm effect and motivation driving perceived change independently from intervention that had not started."[55]	GAS scales are constructed uniquely for each client, according to his/her initial level in relation to the target goal. If preintervention level is not verified, the whole scale may be unreliably constructed (erroneous starting point of the scale generating inappropriate next levels).

Appendix B Continued: Guidelines for GAS Reliability and Validity in Research

Quality Appraisal Items	Item Description	Examples of Reported Criteria, Extracted From Rehabilitation Effectiveness Studies and/or Published Methods That Satisfy Criteria	Potential for Bias Arising From Failure to Report Criteria and/or Utility of Reporting the Criterion
Attainability/difficulty	GAS scales have been verified by an external judge to check for their difficulty/ attainability.	Ruble[27(p14)] compared GAS scales for difficulty in a trial of cognitive intervention: "1: Skill is very close to what the child is already described as able to perform (very easy); 2: The child is able to perform the skill in limited ways compared to what is written in the objective (limited people, prompts, or places…); 3: The child is unable to perform skill with anyone, anywhere, or with any prompts compared to what is written in the objective (difficult)." In a study of infants with motor delays, Palisano[37] asked experts to decide which of the 5 GAS levels the child was most likely to achieve after 3 months, aiming at a maximum of 0 and a minimum of extreme −2 and +2 scores, if GAS levels were decided correctly. Cardillo[53(p53)] reported that realism of the expected level of outcome "for each goal, for this patient, at this time, in this mental health service" was assessed by a scale ranging from 1 (much too difficult) to 5 (much too easy). He also reviews other methods that use 3- or 5-point scales using pessimistic/realistic/ optimistic terms. Such scales could be easily used in physical medicine and rehabilitation to compare attainability/difficulty of goals between 2 groups.	An experimental group may falsely present higher GAS scores postintervention because GAS scales were formulated with easier levels of goal attainment.
Time-specificity	Authors specify if/how longer-term goals were adapted to the specific time frame of the research study. In the case of multiple assessment, authors specify which assessment was taken as the target moment for goal achievement.	In the randomized controlled trial of Lowe et al,[51] children were evaluated at 13 different time points. It is not reported which assessment point was taken as the reference to choose the 0 level (level that will most probably be attained after intervention), criterion unmet.	Goal difficulty across experimental groups may have been unequal at a given assessment point because of differences in time frames for goal completion.
Reliability of scale rating			
IRR	IRR of GAS scales is reported.	In a study of Steenbeek[48] in cerebral palsy, IRR was reported based on 2 judges using video-taped performance of each goal.	Reliability of GAS set by one team (especially an experienced one) does not presume that other GAS scales set by other teams, in other rehabilitation contexts, are reliable. Therefore IRR should be reported for the specific GAS scales generated in each study.

Appendix B Continued: Guidelines for GAS Reliability and Validity in Research

Quality Appraisal Items	Item Description	Examples of Reported Criteria, Extracted From Rehabilitation Effectiveness Studies and/or Published Methods That Satisfy Criteria	Potential for Bias Arising From Failure to Report Criteria and/or Utility of Reporting the Criterion
Criteria affecting IRR			
Precise description of all levels	Five GAS levels have been precisely described preintervention for each scale.	Goal: to reduce weekly shopping expenditure. For the total weekly food/household shopping expenditure: +2 (<$42.99), +1 ($46.99–$43.00), 0 ($54.00–$47.00), −1 ($63.00–$54.01), and −2 (>$63.00).[56]	When all levels of the scales have not been precisely decided and described prior to intervention, authors often use adjectives, such as worse than expected and much better than expected, to score goal attainment. This is a subjective appreciation that may be useful clinically, but it is too imprecise to objectively determine intervention efficacy.
Measurability	GAS scales have been verified by an external judge to check for measurability. Subjective and general goals are transformed into more objective and measurable goal attainment indicators.	Good measurability: observable and objective performance with specified task (eg, a child's goal to fall less is assessed through "an obstacle course including jumping and quick changes of walking direction. The therapist encourages [the child] to complete the course within 3min. Instruction 'Walk the obstacle course fast and don't fall'; GAS levels: -1: falls 3 times, 0: falls 2 times…)."[35(p432)] Unclear measurability: subjective criteria or scored based on interviews rather than direct observation of performance (eg, "I am able to express opinions and feelings two times or more per week…", with no self-assessment method specified[9(p258)]). See Ruble[27,50] for an example of assessment of measurability of social and cognitive goals.	A goal that is not measurable will yield subjective scores, biased by clients' or therapists' feelings/state of mind at the moment of scoring, rather than a reliable measure of goal attainment.
Unidimensionality	GAS scales have been verified by an external judge to check for unidimensionality.	Example of a nonunidimensional scale: "−1: I use 0–1 coping skills consistently and feel depressed and angry more than 40% of the time.; 0: I use 2–3 coping skills consistently and feel depressed and angry 25–40% of the time…"[9(p258)] Example of a truly unidimensional scale: "…−1: Manages to eat a bowl of mashed potatoes unaided but takes more than 15 minutes; 0: Eats a bowl of mashed potatoes in 11 to 15 minutes…"[5(p214)]	Nonunidimensional goals are impossible to score because progress on one dimension may not be accompanied by progress on another dimension and may generate situations where GAS cannot be scored (see Grant and Ponsford[12] for an example). Bi- (multi-) dimensional GASs should be split into 2 (or more) unidimensional GAS prior to intervention start.
Context of measurement	Context of performance measurement is clearly defined (prompts, cueing, support, amount of help/guidance, location…) and is controlled for during GAS rating OR changes in context are carefully manipulated across the GAS levels, with one change per level at a time.[2]	For example, setting/prompting/guidance: "in order to create an irregular surface, a ladder is placed horizontally at a height of 15cm, the girl is asked to walk barefoot without orthosis, as quickly as possible, through the rungs over a distance of 8 meters. Only if she falls a therapist will help her holding one of her hands."[48(p276)] For example, "GAS level −1: Prepares school bag but requires constant verbal guidance from the parents or teacher; GAS level 0: Manages to prepare the school bag using a check-list of necessary steps and under supervision; GAS level +1: Manages to prepare school bag alone, using a check-list of necessary steps; GAS level +2: No supervision required, child only occasionally forgets items."[5(p214),55(p11)]	Context of measurement influences performance on a given target goal (environment, fatigue, help provided…). These factors must be controlled to increase GAS scoring reproducibility.
Other criteria			
Training	Researchers setting the GAS with the client and verifying GAS have received training in writing GAS, have practiced GAS writing, are aware of potential sources of bias in GAS, and are experienced in the goal domain/population.	Although training in GAS writing is reported as being important,[43] and successful training methods have been published,[41] most studies do not report on therapists' training. Some studies report to which practical GAS guide[2,4] they refer to, but without mention of training.[57,58] Those mentioning training do not explain the type of training (eg, "Experienced pediatric occupational therapists were trained in and completed the GAS collaboratively with the families, thus enhancing the reliability of the GAS."[63(p194)]).	Given the numerous and complex potential sources of bias in GAS processes, a team that is not experienced in using GAS methodology is unlikely to produce valid and reliable GAS. Further, a team without specific experience in the goal domain or the specific population with whom the intervention is tested will have difficulty in predicting what can be attained in a given time frame, even if experienced in GAS methodology in another domain (risk of unrealistic goals, unequal difficulty across clients, irrelevant goals to the specific population…).

Appendix B Continued: Guidelines for GAS Reliability and Validity in Research

Quality Appraisal Items	Item Description	Examples of Reported Criteria, Extracted From Rehabilitation Effectiveness Studies and/or Published Methods That Satisfy Criteria	Potential for Bias Arising From Failure to Report Criteria and/or Utility of Reporting the Criterion
Examiner bias	The person scoring the GAS at the end of the intervention is independent from the team who set the GAS (and independent from the team that provided the intervention; however, the latter is not a GAS-specific criterion).	For example, "Goals were chosen and set before the patient was allocated to a group…goal attainment was scored by an independent assessor at post-treatment and at follow-up."[57(p841)] For example, "The therapist-GAS was scored from video by blind evaluators. The parent-GAS was scored by two blinded occupational therapists."[51(p824)]	If the same person sets the GAS and scores them, he/she is likely to be biased toward scoring a maximum of 0 (attained as expected). He/she may rely on memory of initial performance and subjective impression of improvement to score ambiguous progress. The independence of the assessor should also be respected when goals are client/family chosen when GAS is an outcome measure in research (in contrast with clinical practice, where GAS scoring by the client may be relevant and appropriate).
Statistical analysis	Ordinal nature of GAS scales is preserved using nonparametric statistics (rank tests, medians, box plots).	For example, "It was decided not to use the popular T score in order to preserve the ordinal nature of the data…group effects were demonstrated by testing the difference between all medians…using a two-tailed Wilcoxon signed ranks test."[48(p277)]	The performance of arithmetic operations (eg, T scores on ordinal data) is scientifically not valid[23] and should be discouraged because it yields erroneous interpretation of data. In GAS, the problem is multiplied by characteristics of the T score formulae (unknown true value of ρ, T score variation according to the number of goals per client even at equal degree of attainment, highly subjective weighting of goals, which although clinically meaningful, introduces further potential arithmetic incoherence in the final T score).
Example of GAS	One (or more) example of a typical GAS full scale, extracted from the trial, is provided. A list of chosen goals is reported.	Some authors provide an example of the full GAS scale in the article[48,56,59] in the methods or results section. Examples of goal types can be given (1) by providing examples of goal in the articles[42,52,60–62]; (2) by reporting chosen goals in the appendix[12,60]; or (3) by reporting goal type and frequency of each type without providing an exhaustive goal list.[48,63,64]	Providing examples allows the reader a quick judgment/idea of goal type, precision of goal and levels description, measurability, and unidimensionality of GAS. The lack of GAS examples contributes to make GAS seem like an abstract outcome measure: unlike standardized scales, the reader cannot build a representation of the target goals of the intervention. Therefore, reporting all goals in an appendix and providing example(s) of full GAS scales (representative of different domains measured)

Appendix C: Participant / Significant Other Interview Questions (Intake Form)

Inclusionary Questions

1. When were you officially diagnosed with PD?
2. What were your initial motor symptoms? When did they begin?
3. Please list the medications you are currently taking.
4. Have you noticed any changes in your thinking or memory since your diagnosis?
5. (If yes) Have these changes caused any daily activities to become more challenging?
6. (If yes) Which activities?
7. (If yes) Why do you think these activities have become more challenging?
8. How long have you been having difficulty with X activities?
9. Which of these difficult activities restrict you the most from living the life you want to live?
10. How important is it for you to improve your ability to complete those activities?
11. What else would you like to let us know?
12. The design of this study requires that all participants attend all treatment sessions (2 times a week for 8 weeks) and 2 follow up assessments. Treatment was from X date to X date, and one assessment was immediately after the treatment phase from X date to X date. Another assessment was 1-month later from X date to X date. If you are selected for the study, will you be available to come to the laboratory for all treatment sessions and follow up assessments?

Appendix C Continued: Participant / Significant Other Interview Questions (Intake Form)

Exclusionary Questions

1. Is English your first language?
2. Do you have deep brain stimulation?
3. Have you ever had a stroke, a traumatic brain injury, or any other neurologic disease or condition beyond PD?
4. Did you have a preexisting learning disability before you were diagnosed with PD?
5. Do you have significant difficulty seeing or reading things that are within your reach, even when using corrective lenses?
6. Are you currently receiving cognitive therapy?
7. If you are selected for the study, you can only receive the treatment offered by the study from X date to X date. Are you planning on receiving cognitive therapy from a different therapist outside of the study from X date to X date?

Appendix D: Compensation Techniques Inventory and Needs Assessment

(as found in M. M. Sohlberg & L. S. Turkstra, 2011, pp. 176-178)

Compensation Techniques Inventory

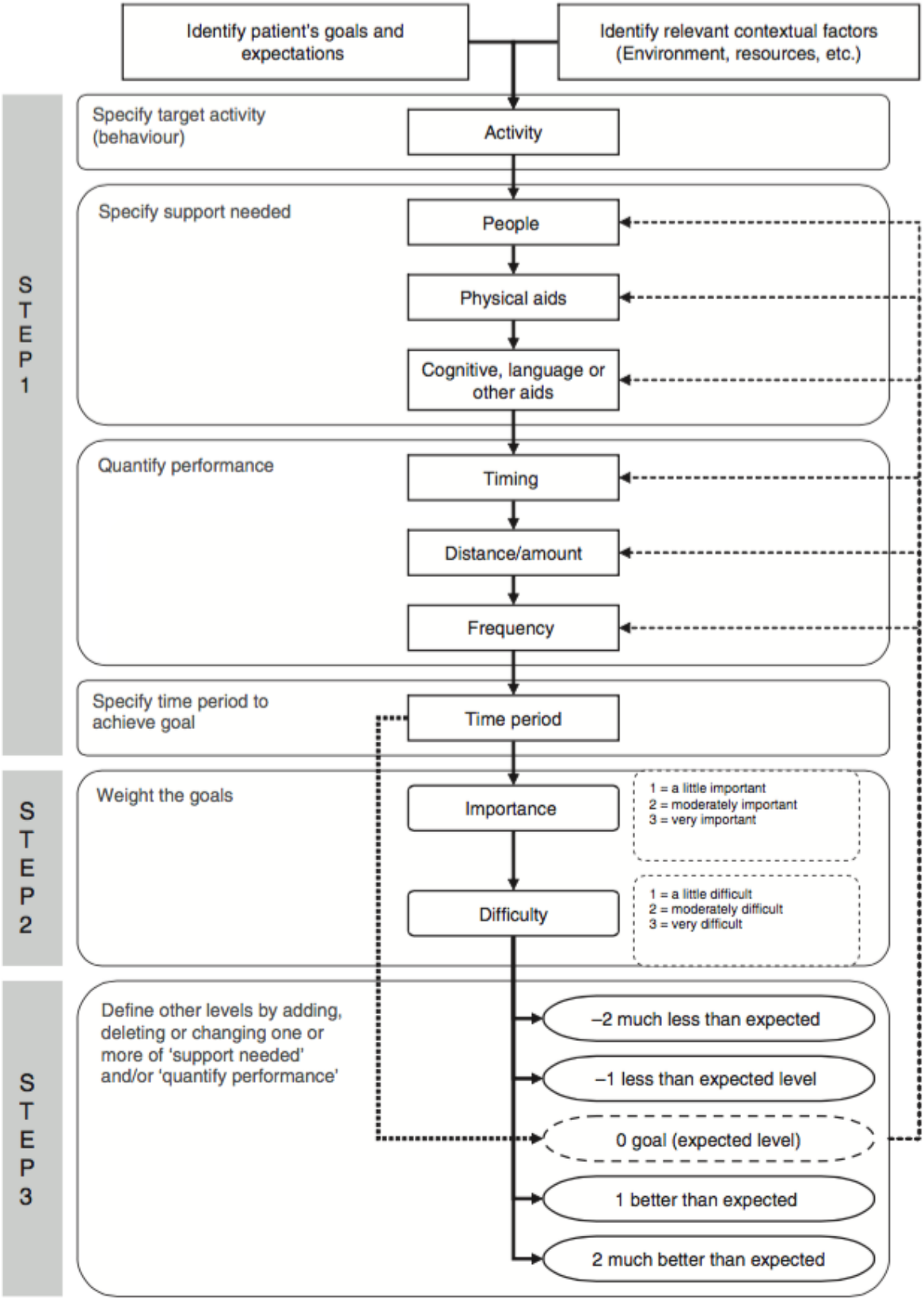
Client Name:		Date:	
I. **Independence Screen**			
Life Tasks	**How much help needed? (see rating scale)**	**Comments (check any that are important goal areas)**	✓
Making appointments			
Financial management			
Social arrangements			
Shopping			
Meal planning and preparation			
Cleaning			
Laundry			
Driving			
Personal care			
1 = unable; 2 = lots of help; 3 = occasional help; 4 = reminders only; 5 = independent			
II. **Functional Cognition Screen**			
Cognitive Issue	**Frequency of Problem (see rating scale)**	**Comments (check any that really bother you)**	✓
Don't know the date			
Miss appointments			
Lose keys			
Double schedule			
Forget to complete tasks at home or work			
Don't know what appointments are coming up next week			
Have trouble organizing days and tasks that need to be completed			
Start but don't finish tasks			
Lose track of time			
Cannot stay focused and return to task when interrupted			
Forget what I did yesterday			
1 = happens constantly; 2 = happens frequently; 3 = happens occasionally; 4 = rarely happens; 5 = not an issue			

Appendix D Continued: Compensation Techniques Inventory and Needs Assessment

Compensation Techniques Inventory *(page 2 of 3)*

Past and Current Compensation Use				
Type of Aid	**Frequency of Use PRIOR**	**How Useful PRIOR**	**Frequency of Use NOW**	**How Useful NOW**
EXTERNAL SCHEDULING AIDS				
Wall Calendar *Location* _____				
• Enter scheduled events				
• Enter "things to do"				
• Refer to entries				
• Check off entries				
• Reschedule as needed				
Planner *Type* _____				
• Enter scheduled events				
• Enter "things to do"				
• Refer to entries				
• Set alarm				
• Check off entries				
• Reschedule as needed				
Electronic Scheduler *Type* _____				
• Enter scheduled events				
• Enter "things to do"				
• Refer to entries				
• Set alarm				
• Check off entries				
• Reschedule as needed				
OTHER EXTERNAL AIDS				
Voice recorder				
Car memo pad				
Digital stopwatch				
Wristwatch				
Bulletin board with notes				
Home filing system				
Post-it notes				
Reminders on fridge				
Pill reminder system				
Voice mail				
Calculator				
Camera				
Others:				

Appendix E. Writing Goal Attainment Scaling Goals (Bovend'Eerdt et al., 2009)



Appendix F. P2's GAS Lab and Home Goals

Lab Goal 1 (medication management) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 1: Medication Management, Part A (Taking Meds-Accuracy)				
-2	**-1**	**0**	**+1**	**+2**
Across 7 trials, when given a pill organizer and audible + visual alarms (prompting her to take meds) P2 will…				
*Make 4 mistakes	Make 3 mistakes	Make 2 mistakes	Make 1 mistake	Make 0 mistakes **ACHIEVED[P,M]**
Note. Mistakes are defined as choosing the wrong day and/or time compartment: morning, noon, evening, bed.				
Lab Goal 1: Medication Management, Part B (Taking Meds-Effort)				
Across 7 trials, The effort it takes P2 to take the correct medications will be				
[NB]Extremely Effortful	Extremely—moderately effortful	Moderately effortful **ACHIEVED[M]**	Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED[P]**
Lab Goal 1: Medication Management, Part C (Alarm + Meds)				
When given the scenario that she is eating a meal while her alarm activates, P2 will accurately set an alarm for 45 minutes titled "take pills" (prompting her to take pills at the later time)…				
*0 times.	1 time.	2 times.	3 times.	4 times. **ACHIEVED[P,M]**

[P] = Post-treatment, [M] = Maintenance * = Baseline Score [NB]= No Baseline Score

Appendix F Continued. P2's GAS Lab and Home Goals

Table X. Lab Goal 2 (misplaced items) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 2: Finding Misplaced Items, Part A				
-2	**-1**	**0**	**+1**	**+2**
The Tile Bluetooth tracker will be given to P2. When items are out-of-sight ('misplaced') 4 times, P will find items using the Tile tracker:				
0 times.	1 times.	*2 times.	3 times. **ACHIEVED^{M}**	4 times. **ACHIEVED^{P}**
Note. Items include: iPhone, keys, wallet, and glasses container.				
Lab Goal 2: Finding Misplaced Items, Part B				
The Tile Bluetooth tracker will be given to P2. For items that are found, it will take her an **average** of:				
2.5 - 3 minutes to find each item.	2 - 2.5 minutes to find each item.	1.5 to 2 minutes to find each item. **ACHIEVED^{M}**	*1 - 1.5 minutes to find each item. **ACHIEVED^{P}**	30 seconds – 1 minute to find each item.

Appendix F Continued. P2's GAS Lab and Home Goals

Table X. Lab Goal 3 (desk organization) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 3: Desk Organization, Part A				
-2	**-1**	**0**	**+1**	**+2**
*Across 5 trials: When given 15 notes and objects, triggered by an audible + visual alarm prompting task, P2 will correctly organize (on **average**):*				
0-3 objects into their designated spaces	4-6 objects into their designated spaces.	7-9 objects into their designated spaces	*10-12 objects into their designated spaces	13-15 objects into their designated spaces. **ACHIEVED^{P,M}**
Lab Goal 3: Desk Organization, Part B (All correct)				
Across 5 trials: When given 15 notes and objects, triggered by an audible + visual alarm prompting task, P2 will:				
*Correctly organize all objects into their designated spaces for 0-1 of 5 trials.	Correctly organize all objects into their designated spaces) for 2 of 5 trials.	Correctly organize all objects into their designated spaces for 3 of 5 trials.	Correctly organize all objects into their designated spaces for 4 of 5 trials. **ACHIEVED^{M}**	Correctly organize all objects into their designated spaces for 5 of 5 trials. **ACHIEVED^{P}**
Lab Goal 3: Desk Organization, Part C				
*Across 5 trials: When given 15 notes and objects, triggered by an audible + visual alarm prompting task, P2 it will take her **(on average)***				
4 -5 minutes to organize items.	*3- 4 minutes to organize items.	2 -3 minutes to organize items. **ACHIEVED^{P,M}**	1 -2 minutes to organize items.	0 - 1 minutes to organize items.
Designates spaces include on the desk and in hanging files beside desk.				

* = Baseline Score, ^{P} = Post-treatment, ^{M} = Maintenance

Appendix F Continued. P2's GAS Lab and Home Goals

Lab Goal 4 (scheduling appointments) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 4: Scheduling Appointments While on Phone, Part A				
-2	**-1**	**0**	**+1**	**+2**
When scheduling (simulated) appointments while on the phone (4 different phone calls across a week):				
P2 will remain on the phone for 0 of 4 calls to schedule appointments.	P2 will remain on the phone for 1 of 4 calls to schedule appointments.	P2 will remain on the phone for 2 of 4 calls to schedule appointments.	P2 will remain on the phone for 3 of 4 calls to schedule appointments. **ACHIEVED^{P}**	*P2 will remain on the phone for 4 of 4 calls to schedule appointments. **ACHIEVED^{M}**
Lab Goal 4: Scheduling Appointments While on Phone, Part B				
When scheduling (simulated) appointments while on the phone (4 different phone calls across a week):				
P2 will schedule 0 of 4 appointments at available times (not overlapping with scheduled appointments).	P2 will schedule 1 of 4 appointments at available times (not overlapping with scheduled appointments).	*P2 will schedule 2 of 4 appointments at available times (not overlapping with scheduled appointments).	P2 will schedule 3 of 4 appointments at available times (not overlapping with scheduled appointments).	P2 will schedule 4 of 4 appointments at available times (not overlapping with scheduled appointments). **ACHIEVED^{P,M}**
Lab Goal 4: Scheduling Appointments While on Phone, Part C				
For (simulated) appointments scheduled on the phone (4 different phone calls across a week), she will take an average of:				
*2 to 2 ½ minutes to make each appointment.	1 ½ to 2 minutes to make each appointment.	1 to 1 ½ minutes to make each appointment. **ACHIEVED^{P,M}**	30 seconds to 1 minute to make each appointment.	0 to 30 seconds to make each appointment.

^{P} = Post-treatment, ^{M} = Maintenance * = Baseline Score ^{NB}= No Baseline Score

Appendix F Continued. P2's GAS Lab and Home Goals

Lab Goal 5 (daily calendar) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 5: Looking at Her Daily Calendar				
-2	**-1**	**0**	**+1**	**+2**
When 4 audible + visual alarms activate (spaced 5 minutes apart; prompting her to look at her daily calendar), P2 will look at her daily schedule on her iPhone				
[NB] 0 of 4 times.	1 of 4 times.	2 of 4 times.	3 of 4 times.	4 of 4 times. **ACHIEVED[P,M]**

[P] = Post-treatment, [M] = Maintenance * = Baseline Score [NB]= No Baseline Score

Lab Goal 6 (scheduling week) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Lab Goal 6: Scheduling Her Week				
-2	**-1**	**0**	**+1**	**+2**
When given a list of 4 appointments to schedule:				
*Using voice command, P2 will accurately schedule 0 appointments into her phone calendar.	Using voice command, P2 will accurately schedule 1 appointment into her phone calendar.	Using voice command, P2 will accurately schedule 2 appointments into her phone calendar. **ACHIEVED[P]**	Using voice command, P2 will accurately schedule 3 appointments into her phone calendar. **ACHIEVED[M]**	Using voice command, P2 will accurately schedule 4 appointments in her phone calendar.

Appendix F Continued. P2's GAS Lab and Home Goals

Home Goal 1 (medication management) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 1: Medication Management, Part A (Taking Meds-Accuracy)				
-2	**-1**	**0**	**+1**	**+2**
When given a pill organizer and audible + visual alarms (prompting her to take meds) P2 will…				
Make 4 mistakes	Make 3 mistakes	*Make 2 mistakes	Make 1 mistake	Make 0 mistakes **ACHIEVED^{P,M}**
Note. P2 takes pills 3 times/day, 7 days/week, equaling 21 times/week she needs to take pills. Mistakes are defined as taking medications at the wrong time, not taking medications, or taking medications from an incorrect day or compartment: morning, noon, evening, bed.				
Home Goal 1: Medication Management, Part B (Taking Meds-Effort)				
When given a pill organizer and audible + visual alarms (prompting her to take meds); The effort it takes P2 to take the correct medications will be				
Extremely Effortful	Extremely—moderately effortful	Moderately effortful **ACHIEVED^{P}**	*Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{M}**
Home Goal 1: Medication Management, Part C (Filling Meds-Accuracy)				
Across 1 week, she will be ____% accurate in correctly filling her pills in her pill organizer:				
*80%	85%	90% **ACHIEVED^{M}**	95%	100% **ACHIEVED^{P}**
Home Goal 1: Medication Management, Part D (Filling Meds-Effort)				
The effort it takes P2 to correctly fill her pills in her pill organizer will be:				
Extremely effortful	Extremely-Moderately Effortful	*Moderately Effortful	Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{P,M}**
Home Goal 1: Medication Management, Part E (Alarms + Meds)				
If alarm for medication activates when she is eating a meal, P2 will set alarm for 45 minutes (prompting her to take pills at the later time)…				
*None of the time.	Some of the time.	Half of the time.	Most of the time. **ACHIEVED^{P}**	All of the time.

* = Baseline Score, ^{P} = Post-treatment, ^{M} = Maintenance, ^{NB}= No Baseline Score

Appendix F Continued. P2's GAS Lab and Home Goals

Home Goal 2 (misplaced items) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 2: Finding Misplaced Items, Part A (Use)				
-2	**-1**	**0**	**+1**	**+2**
The Tile Bluetooth tracker will be given to P2. *For days when items are misplaced throughout the week, she will use her Tile % of the time to find misplaced items.*				
0% (she will never use the Tile).	*25% (she will use the Tile some of the time). **ACHIEVED^{P}**	50% (she will use her tile half of the time).	75% (She will use the Tile most of the time).	100% (She will use the tile all of the time). I was able to quickly find all items this past week using Tile.
Note. Items include: iPhone, keys, wallet, and glasses container.				
Home Goal 2: Finding Misplaced Items, Part B (Success)				
The Tile Bluetooth tracker will be given to P2. *When P2 used her Tile to find misplaced items throughout the week, she will to find of her misplaced items.*				
^{NB} 0% (none)	25% (some) **ACHIEVED^{P}**	50% (half)	75% (most) **ACHIEVED^{M}**	100% (all)
Home Goal 2: Finding Misplaced Items, Part 3 (Speed)				
The Tile Bluetooth tracker will be given to P2. *When she finds misplaced items throughout the week, it will take her _____ to find her items than before she had the Tile (looking for items by herself).*				
^{NB} Much longer	Slightly Longer **ACHIEVED^{M}**	The same amount of time	Slightly less time	Much less time **ACHIEVED^{P}**

^{P} = Post-treatment, ^{M} = Maintenance * = Baseline Score ^{NB}= No Baseline Score

Appendix F Continued. P2's GAS Lab and Home Goals

Home Goal 3 (desk organization) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 3: Desk Organization, Part A				
-2	**-1**	**0**	**+1**	**+2**
When daily audible and visual alarm activates, P2 will categorize objects on/in desk into their designated spaces…				
0 days per week.	1-2 days per week.	3-4 days per week.	*5-6 days per week. **ACHIEVED^{P,M}**	7 days per week.
Objects include ongoing projects (i.e. passport documentation), sticky notes, check-lists, daily notes, jewelry, paperwork, pencils/pens.				
Home Goal 3: Desk Organization, Part B				
On the final evening of the week, objects on/in her desk will be:				
*Not at all organized.	Somewhat organized.	Half will be organized.	Most will be organized.	All will be organized. **ACHIEVED^{P,M}**
Home Goal 3: Desk Organization, Part C				
The effort it takes P2 to organize her desk across one week will be:				
Extremely effortful	*Extremely-Moderately Effortful	Moderately Effortful	Moderately-Minimally Effortful	Minimally Effortful **ACHIEVED^{P,M}**

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

Table X. Home Goal 4 (scheduling appointments) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 4: Scheduling Appointments While on Phone, Part A				
-2	**-1**	**0**	**+1**	**+2**
When scheduling appointments while on the phone across the week:				
^{NB} P2 will not remain on the phone for any calls involving scheduling.	P2 will remain on the phone for some calls involving scheduling.	P2 will remain on the phone for half of calls involving scheduling.	P2 will remain on the phone for most calls involving scheduling.	P2 will remain on the phone for each call involving scheduling. **ACHIEVED^{P,M}**

Appendix F Continued. P2's GAS Lab and Home Goals

Table X. Home Goal 5 (daily calendar) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 5: Looking at Her Daily Calendar				
-2	**-1**	**0**	**+1**	**+2**
When 21 audible + visual alarms activate throughout her week (as a prompt to look at her daily calendar 3 times per day):				
*Across the week, P2 will not look at her daily calendar following alarms. **ACHIEVED^{P}**	Across the week, P2 will look at her daily calendar sometimes following alarms. **ACHIEVED^{M}**	Across the week, P2 will look at her daily calendar half the time following alarms.	Across the week, P2 will look at her daily calendar often following alarms.	Across the week, P2 will look at her daily calendar every time following alarms.

Table X. Home Goal 6 (scheduling week) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 6: Scheduling Her Week				
-2	**-1**	**0**	**+1**	**+2**
Prior to the start of each week:				
P2 will accurately schedule 0-19% appointments into her phone calendar.	P2 will accurately schedule 20-39% of appointments into her phone calendar.	P2 will accurately schedule 40-59% of appointments into her phone calendar.	*P2 will accurately schedule 60-79% of appointments into her phone calendar.	P2 will accurately schedule 80-100% of appointments in her phone calendar. **ACHIEVED^{P,M}**

^{P} = Post-treatment, ^{M} = Maintenance * = Baseline Score ^{NB}= No Baseline Score

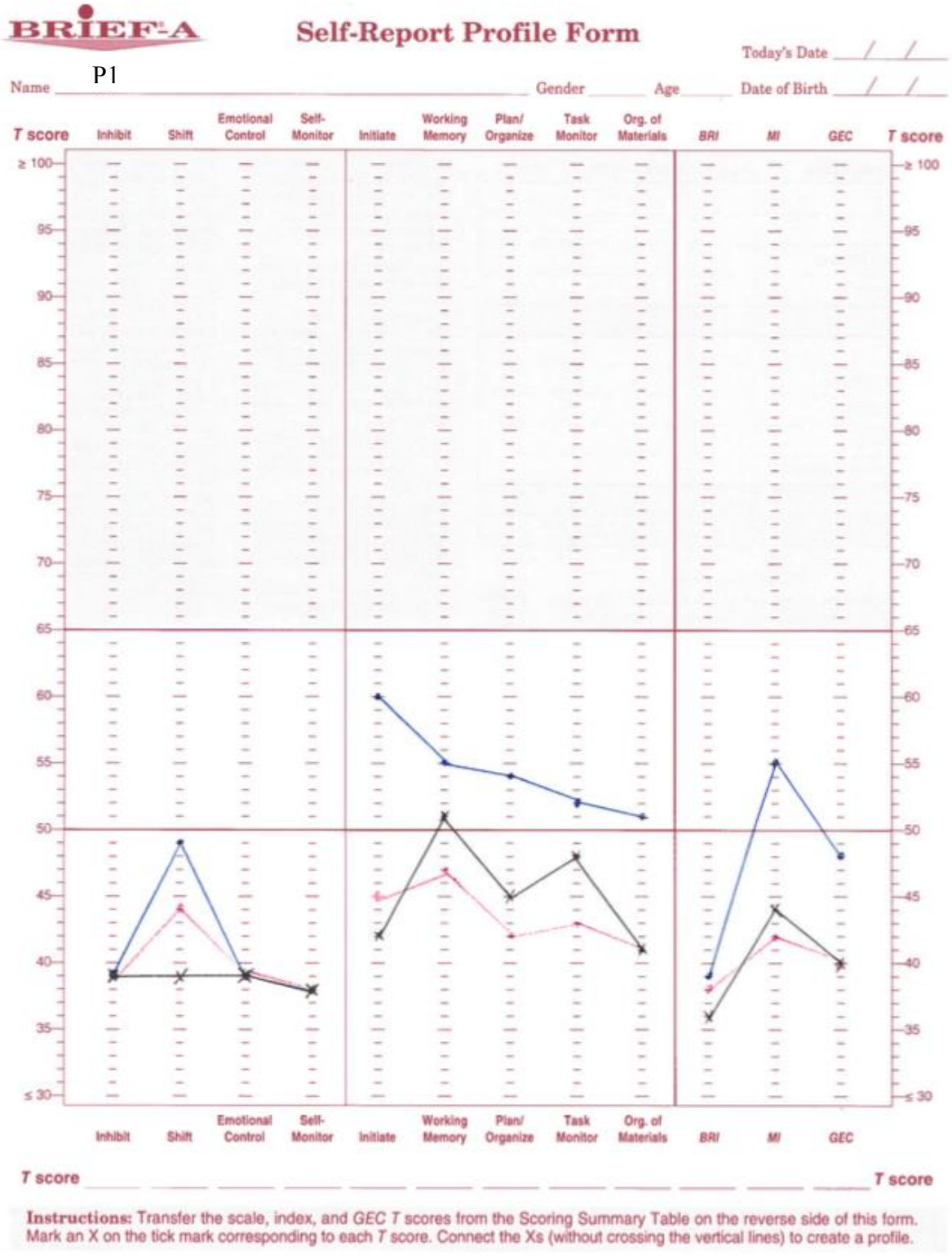
Appendix F Continued. P2's GAS Lab and Home Goals

Home Goal 7 (arriving on time) for P2 and level of goal achievement post-treatment (P) and during 1-month maintenance (M).

Home Goal 7: Arriving on Time				
-2	**-1**	**0**	**+1**	**+2**
P2 will make it to (not miss)				
60% of appointments across 1 week.	70% of appointments across 1 week.	*80% of appointments across 1 week.	90% of appointments across 1 week.	100% of appointments across 1 week. **ACHIEVED^{P,M}**

* = Baseline Score ^{P} = Post-treatment, ^{M} = Maintenance ^{NB}= No Baseline Score

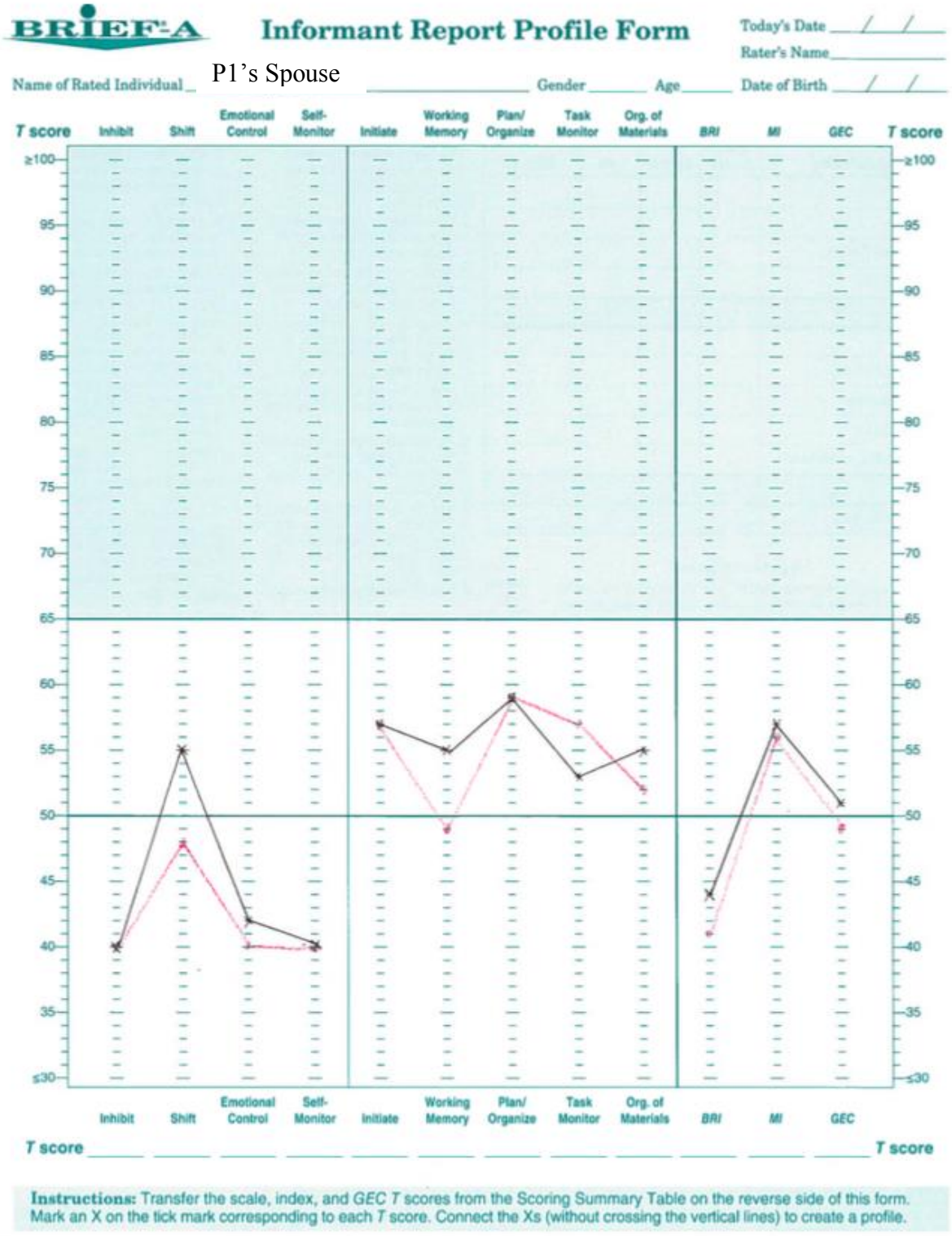
Appendix G: Participant / Significant Other BRIEF-A Questionnaires



Baseline = — Post-Treatment = — Maintenance = —

(T-scores ≥ 65 are considered clinically significant)

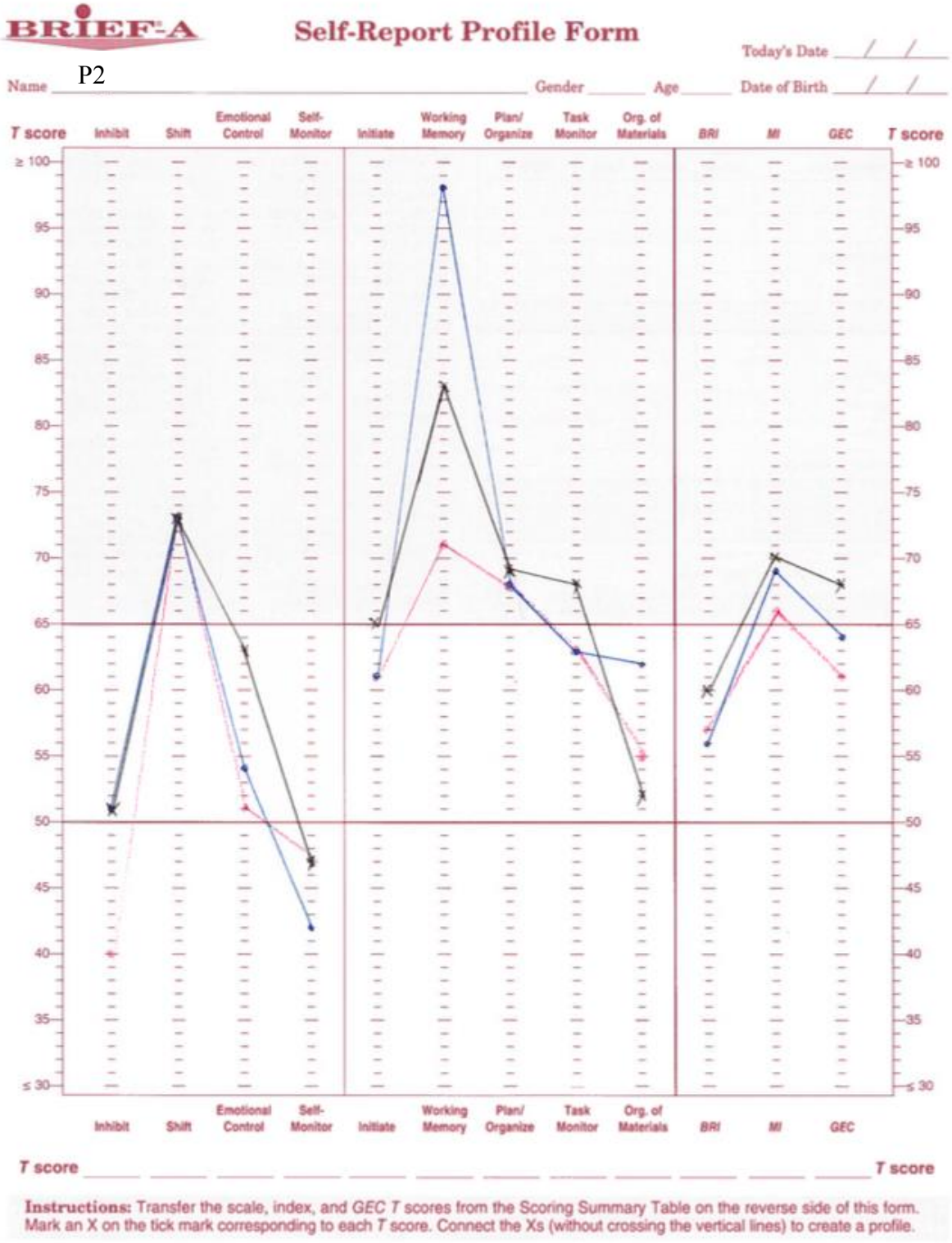
Appendix G Continued: Participant / Significant Other BRIEF-A Questionnaires



Baseline = — Post-Treatment = — Maintenance = —

(T-scores ≥ 65 are considered clinically significant)

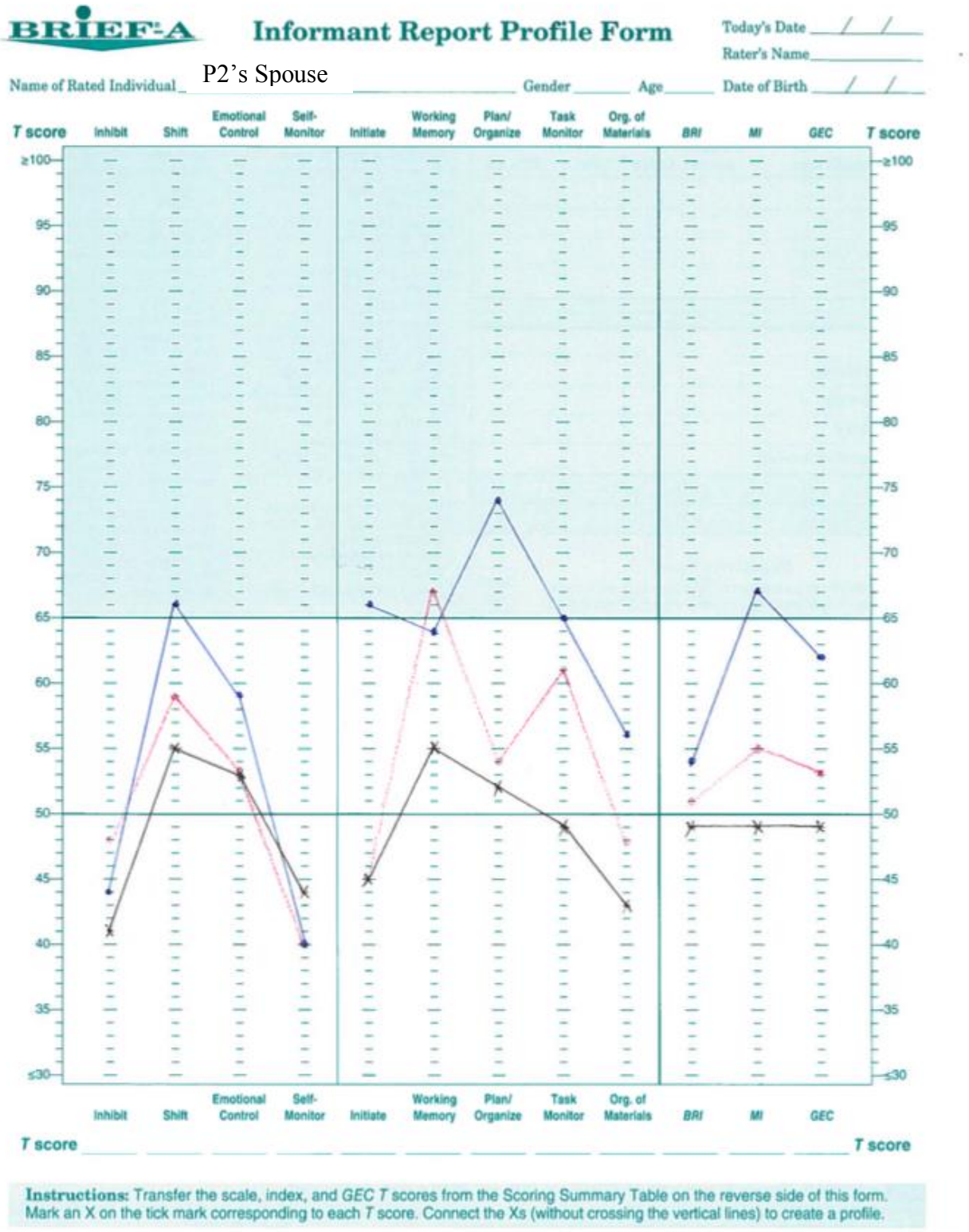
Appendix G Continued: Participant / Significant Other BRIEF-A Questionnaires



Baseline = Post-Treatment = Maintenance =

(T-scores ≥ 65 are considered clinically significant)

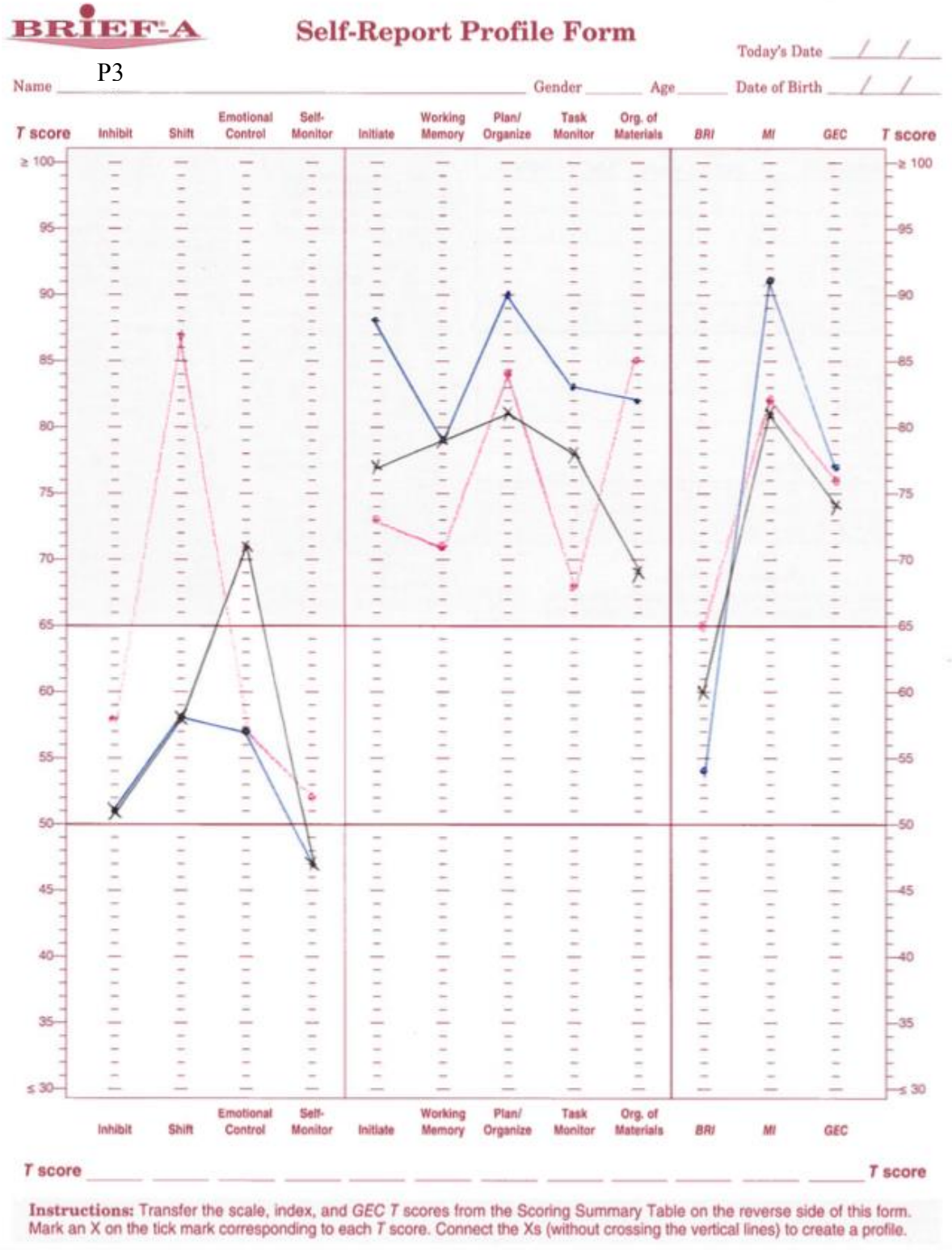
Appendix G Continued: Participant / Significant Other BRIEF-A Questionnaires



Baseline = — Post-Treatment = — Maintenance = —

(T-scores ≥ 65 are considered clinically significant)

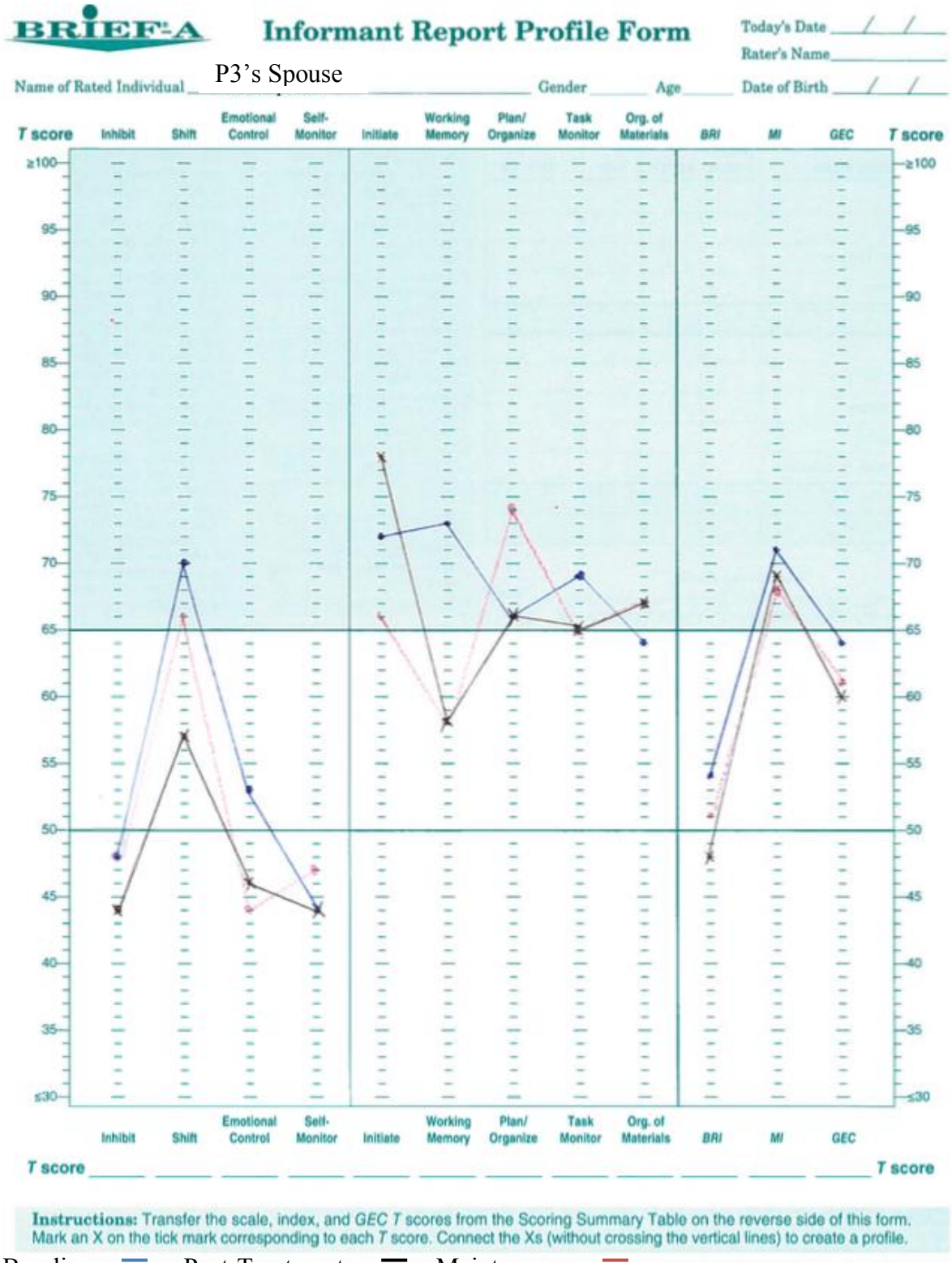
Appendix G Continued: Participant / Spouse BRIEF-A Questionnaires



Baseline = — Post-Treatment = — Maintenance = —

(T-scores ≥ 65 are considered clinically significant)

Appendix G Continued: Participant / Spouse BRIEF-A Questionnaires



Baseline = — Post-Treatment = — Maintenance = —

(T-scores ≥ 65 are considered clinically significant)

Appendix H: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

Independence Screen						
	P1			P1's Spouse		
Life Tasks	**Baseline**	**Post**	**Maintenance**	**Baseline**	**Post**	**Maintenance**
Help making appointments	2	4	4	Not returned	2	2
Financial management	3	4	4	Not returned	2	2
Social arrangements	4	4	4	Not returned	2	2
Shopping	4	5	5	Not returned	5	5
Meal planning and preparation	3	3	4	Not returned	1	2
Cleaning	3	5	5	Not returned	1	1
Laundry	4	5	5	Not returned	5	5
Driving	5	5	4	Not returned	5	5
Personal care	5	5	5	Not returned	4	5

Note. *1 = unable to do; 2 = lots of help; 3 = occasional help; 4 = reminders only; 5 = independent*

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

Functional Cognition Screen						
	P1			P1's Spouse		
Cognitive Issue	**Baseline**	**Post**	**Maintenance**	**Baseline**	**Post**	**Maintenance**
Don't know the date	5	4	5	Not returned	4	4
Miss appointments	4	5	5	Not returned	4	4
Lose keys	3	4	4	Not returned	3	4
Double schedule	4	4	4	Not returned	4	5
Forget to complete tasks at home or work	4	5	4	Not returned	3	5
Don't know what appointments are coming up next week	4	5	4	Not returned	4	2
Have trouble organizing days and tasks that need to be completed	4	5	4	Not returned	4	5
Start but don't finish tasks	4	4	4	Not returned	4	5
Lose track of time	5	4	5	Not returned	2	2
Cannot stay focused and return to task when interrupted	5	5	4	Not returned	4	3
Forgot what I did yesterday	4	5	4	Not returned	5	5

Note. *1 = happens constantly; 2 = happens frequently; 3 = happens occasionally; 4 = rarely happens; 5 = not an issue*

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

P1: Compensation Use						
	Baseline		Post		Maintenance	
External Aid	Frequency	Helpfulness	Frequency	Helpfulness	Frequency	Helpfulness
Wall planner	3	3	3	3	3	3
Planner	0	0	3	3	3	3
Electronic scheduler	0	0	3	2	2	3
Post-it notes	2	2	3	3	0	0
Bulletin board with notes	3	3	3	3	0	0
Reminders on fridge	2	2	2	2	0	0
Pill reminder system	3	3	3	3	0	0
Wristwatch	3	3	3	3	3	3
Home filing system	1	1	3	2	2	2
Voicemail	2	2	0	0	1	2
Calculator	3	3	2	3	2	2
Camera	3	3	3	3	3	3
Others:						
Note Pad	3	3	-	-	-	-
Coordinating schedule w/ spouse	-	-	-	-	3	3

***Note**. Frequency of Use Scale: 0 = never; 1 = 1x/week; 2 = a few times/week; 3 = most days*
Helpfulness Scale: 0 = N/A or not useful; 1 = rarely helps; 2 = pretty helpful; 3 = very helpful
– = Information not provided

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

P1 Spouse: Compensation Use						
	Baseline		Post-Treatment		Maintenance	
External Aids	**Frequency**	**Helpfulness**	**Frequency**	**Helpfulness**	**Frequency**	**Helpfulness**
Wall planner	Not returned	Not returned	3	3	3	3
Planner	Not returned	Not returned	3	3	3	3
Electronic scheduler	Not returned	Not returned	3	3	3	3
Post-it notes	Not returned	Not returned	-	-	-	-
Bulletin board with notes	Not returned	Not returned	-	-	-	-
Reminders on fridge	Not returned	Not returned	-	-	-	-
Pill reminder system	Not returned	Not returned	-	-	-	-
Wristwatch	Not returned	Not returned	-	-	-	-
Home filing system	Not returned	Not returned	-	-	-	-
Voicemail	Not returned	Not returned	-	-	-	-
Calculator	Not returned	Not returned	-	-	-	-
Camera	Not returned	Not returned	-	-	-	-
Others: Note pad	Not returned	Not returned	-	-	-	-

Note*. Frequency of Use Scale: 0 = never; 1 = 1x/week; 2 = a few times/week; 3 = most days*
Helpfulness Scale: 0 = N/A or not useful; 1 = rarely helps; 2 = pretty helpful; 3 = very helpful
– = Information not provided

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

Independence Screen						
	P2			P2's Spouse		
Life Tasks	**Baseline**	**Post**	**Maintenance**	**Baseline**	**Baseline**	**Maintenance**
Help making appointments	4	3	4	5	4	4
Financial management	3	2	3	4	4	3
Social arrangements	4	4	4	3	4	4
Shopping	5	4	5	5	5	5
Meal planning and preparation	4	5	5	4	5	4
Cleaning	5	5	5	5	5	5
Laundry	5	5	5	5	5	5
Driving	3	5	4	5	5	5
Personal care	5	5	5	5	5	5

Note. *1 = unable to do; 2 = lots of help; 3 = occasional help; 4 = reminders only; 5 = independent*

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

Functional Cognition Screen						
	P2			P2's Spouse		
Cognitive Issue	**Baseline**	**Post**	**Maintenance**	**Baseline**	**Post**	**Maintenance**
Don't know the date	2	3	5	5	3	5
Miss appointments	4	4	4	4	4	4
Lose keys	3	3	4	2	4	3
Double schedule	3	3	3	3	4	3
Forget to complete tasks at home or work	3	3	3	3	3	3
Don't know what appointments are coming up next week	2	3	2	2	3	4
Have trouble organizing days and tasks that need to be completed	2	3	3	3	5	5
Start but don't finish tasks	3	4	4	2	4	3
Lose track of time	3	3	3	3	3	3
Cannot stay focused and return to task when interrupted	3	3	3	3	4	3
Forgot what I did yesterday	2	2	3	5	5	3

Note. *1 = happens constantly; 2 = happens frequently; 3 = happens occasionally; 4 = rarely happens; 5 = not an issue*

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

P2: Compensation Use						
	Baseline		Post		Maintenance	
External Aids	**Frequency**	**Helpfulness**	**Frequency**	**Helpfulness**	**Frequency**	**Helpfulness**
Wall calendar	3	3	3	2	3	3
Planner	0	0	0	0	0	0
Electronic scheduler	3	3	2	3	3	3
Post-it notes	2	2	3	3	3	3
Bulletin board with notes	0	0	0	0	0	0
Reminders on fridge	0	0	0	0	0	0
Pill reminder system	3	3	3	3	3	3
Wristwatch	0	0	3	3	3	3
Home filing system	3	2	2	2	2	2
Voicemail	1	2	3	3	3	3
Calculator	1	3	1	3	1	2
Camera	0	0	2	3	1	2
Others:						
Desk organization system	0	0	3	3	3	3
Tile	0	0	0	0	1	3
Notes	3	3	3	2	3	3

***Note**. Frequency of Use Scale: 0 = never; 1 = 1x/week; 2 = a few times/week; 3 = most days*
Helpfulness Scale: 0 = N/A or not useful; 1 = rarely helps; 2 = pretty helpful; 3 = very helpful

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

P2 Spouse: Compensation Use						
	Baseline		Post		Maintenance	
External Aids	Frequency	Helpfulness	Frequency	Helpfulness	Frequency	Helpfulness
Wall calendar	3	3	3	3	3	3
Planner	0	0	0	0	0	0
Electronic scheduler	3	3	3	3	3	3
Post-it notes	2	3	3	3	3	3
Bulletin board with notes	0	0	0	0	0	0
Reminders on fridge	0	0	0	0	0	0
Pill reminder system	3	3	3	3	3	3
Wristwatch	3	3	0	0	3	3
Home filing system	2	1	1	3	2	2
Voicemail	3	3	0	0	3	3
Calculator	1	3	0	0	0	0
Camera	1	3	0	0	1	2
Others: Desk organization system	0	0	3	3	-	-
Tile	-	-	-	-	-	-
Notes	-	-	-	-	-	-

***Note**. Frequency of Use Scale: 0 = never; 1 = 1x/week; 2 = a few times/week; 3 = most days*
Helpfulness Scale: 0 = N/A or not useful; 1 = rarely helps; 2 = pretty helpful; 3 = very helpful
– = Information not provided

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

Independence Screen						
	P3			P3's Spouse		
Life Tasks	**Baseline**	**Post**	**Maintenance**	**Baseline**	**Post**	**Maintenance**
Help making appointments	4	3	3	4	4	3
Financial management	2	2	2	2	2	3
Social arrangements	4	3	5	4	4	5
Shopping	4	4	3	4	4	3
Meal planning and preparation	2	2	2	3	2	3
Cleaning	4	4	5	4	3	3
Laundry	4	5	5	5	5	5
Driving	3	1	1	2	1	1
Personal care	5	5	5	5	5	5

Note. *1 = unable to do; 2 = lots of help; 3 = occasional help; 4 = reminders only; 5 = independent*

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

Functional Cognition Screen						
	P3			P3's Spouse		
Cognitive Issue	**Baseline**	**Post**	**Maintenance**	**Baseline**	**Post**	**Maintenance**
Don't know the date	2	2	3	5	5	5
Miss appointments	3	5	4	4	4	5
Lose keys	2	2	2	4	4	2
Double schedule	3	5	4	5	4	4
Forget to complete tasks at home or work	3	3	2	1	3	3
Don't know what appointments are coming up next week	2	3	2	4	4	4
Have trouble organizing days and tasks that need to be completed	2	3	2	2	3	3
Start but don't finish tasks	2	2	3	1	2	3
Lose track of time	2	1	2	4	4	3
Cannot stay focused and return to task when interrupted	2	3	1	2	4	2
Forgot what I did yesterday	2	2	2	3	3	3

Note. *1 = happens constantly; 2 = happens frequently; 3 = happens occasionally; 4 = rarely happens; 5 = not an issue*

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

P3: Compensation Use						
	Baseline		Post		Maintenance	
External Aids	Frequency	Helpfulness	Frequency	Helpfulness	Frequency	Helpfulness
Wall planner	3	3	1	3	0	0
Planner	3	2	1	3	0	0
Electronic scheduler	0	0	2	3	2	2
Post-it notes	3	2	3	3	3	3
Bulletin board with notes	2	3	3	3	0	0
Reminders on fridge	0	0	0	0	0	0
Pill reminder system	3	3	3	3	3	3
Wristwatch	3	3	3	3	3	3
Home filing system	0	0	0	0	3	3
Voicemail	0	0	0	0	1	0
Calculator	1	3	0	0	0	0
Camera	0	0	0	0	0	0
Others:						
Notebook	-	-	-	-	2	3
Reminders from Spouse	-	-	-	-	3	3

Note*. Frequency of Use Scale: 0 = never; 1 = 1x/week; 2 = a few times/week; 3 = most days*
Helpfulness Scale: 0 = N/A or not useful; 1 = rarely helps; 2 = pretty helpful; 3 = very helpful
– = Information not provided

Appendix H Continued: Participant / Spouse Compensation Techniques Inventories Across Baseline, Post-Treatment, and 1-Month Maintenance Periods

P3 Spouse: Compensation Use						
	Baseline		Post		Maintenance	
External Aids	**Frequency**	**Helpfulness**	**Frequency**	**Helpfulness**	**Frequency**	**Helpfulness**
Wall planner	0	0	3	3	3	3
Planner	3	3	0	0	3	3
Electronic scheduler	0	0	3	3	2	2
Post-it notes	2	3	3	3	3	3
Bulletin board with notes	0	0	0	0	-	-
Reminders on fridge	2	3	0	0	-	-
Pill reminder system	3	3	3	3	-	-
Wristwatch	3	3	3	3	3	3
Home filing system	1	0	0	0	-	-
Voicemail	2	3	0	0	-	-
Calculator	0	0	0	0	-	-
Camera	0	0	0	0	-	-
Others:						
Whiteboards	-	-	-	-	3	3
Checklists	-	-	-	-	3	3

***Note**. Frequency of Use Scale: 0 = never; 1 = 1x/week; 2 = a few times/week; 3 = most days*
Helpfulness Scale: 0 = N/A or not useful; 1 = rarely helps; 2 = pretty helpful; 3 = very helpful
– = Information not provided

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