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Clock Drawing Is Sensitive to Executive Control: A Comparison of Six Methods

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We examined six clock-drawing task (CDT) scoring systems relative to the Executive Interview (EXIT25, a measure of Executive Control Function [ECF]) and the Mini-Mental State Exam (MMSE). Subjects included* n *= 33 National Institute of Neurological, Communicative Disorders, and Stroke "probable" Alzheimer's disease (AD) cases and* n *= 52 independent living controls. AD cases and controls differed on the EXIT25, MMSE, and all CDTs. All CDTs were significantly correlated with the EXIT25 (ranging from* r *= .56 to* r *= .78). These associations generally persisted after adjusting for Age, Education, and MMSE scores. In backwards stepwise linear multivariate regression models, only CLOX: An Executive Clock-Drawing Task scores contribute significantly to EXIT25 scores (R^2 = .68) and MMSE scores (R^2 = .72). Clock drawing draws upon both executive and general cognitive resources. CLOX explains incrementally more variance in ECF than other CDTs.

CLOCK-DRAWING tests (CDTs) are a potentially rapid and cost-effective method of screening for dementia (Sunderland et al., 1989; Wolf-Klein, Silverstone, Levy, Brod, & Breuer, 1989). They have been shown to be reliable, well tolerated and effective, both for detection and longitudinal assessment (Huntzinger, Rosse, Schwartz, Ross, & Deutsch, 1992; Libon, Malamut, Swenson, Prouty Sands, & Cloud, 1996; Shulman, Shedletsky, & Silver, 1986; Shulman, Pushkar Gold, Cohen, & Zucchero, 1993; Sunderland et al., 1989; Tuokko, Hadjistavropolous, Miller, & Beatties, 1992; Watson, Arfken, & Birge, 1993; Wolf-Klein et al., 1989). Moreover, they do not appear to be influenced significantly by language or cultural factors (Shulman et al., 1993).

However, several CDTs are available (Libon et al., 1996; Manos & Wu, 1994; Mendez, Ala, & Underwood, 1992; Rouleau, Salmon, & Butters, 1996; Royall, Cabello, & Polk, 1998; Shulman et al., 1986; Sunderland et al., 1989; Tuokko et al., 1992; Wolf-Klein et al., 1989), each varying slightly in the details of its administration and scoring (Table 1). The widest variations occur with regard to three aspects: (a) whether a predrawn circle is provided; (b) what time is to be set on the clock; and (c) whether the clock is drawn freehand or copied.

These apparently minor variations in CDT protocols may result in differential sensitivity to important cognitive domains (Royall, 1996). Thus, some authors suggest that their CDTs assess temporoparietal brain functions (Critchley, 1953; Forstl, Burns, Levy, & Cairns, 1993; Ishiai, Sugushuta, Ichikawa, Gono, & Watabiki, 1993; Mesalum, 1985; Moore & Wyke, 1984; Morris et al., 1989), whereas others suggest that clock drawing is sensitive to semantic memory or other factors (Libon et al., 1996).

We are interested in clock drawing's ability to measure executive control functions (ECFs; Royall, Cordes, & Polk, 1998). ECFs are cognitive processes that coordinate simple ideas and actions into complex goal-directed behaviors (Duncan, 1986; Royall, 1994; Royall & Mahurin, 1996; Royall, Mahurin, & Gray, 1992; Stuss & Benson, 1986). Examples include goal selection, motor planning/sequencing, selective attention, and the self-monitoring of one's current action plan. All of these ECFs are required for successful clock drawing.

It is important to measure ECFs because executive impairment is strongly associated with functional disability (Royall, Cabello, & Polk, 1998) as well as with many significant illnesses, including Alzheimer's disease (AD), major depression, multiple sclerosis, Parkinson's disease, and schizophrenia (Channon, 1996; Cummings, 1993; Foong et al., 1997; Royall & Mahurin, 1996; Royall & Polk, 1998; Royall et al., 1992; Royall et al., 1993). Unfortunately, few bedside cognitive measures have been designed to assess ECFs directly, and formal ECF tests are seldom practical for routine use in clinical settings.

We have developed a CDT (CLOX: An Executive Clock-Drawing Task) to measure ECFs specifically (Royall, Cordes, & Polk, 1998). CLOX is divided into two parts. CLOX1 is an unprompted task that is sensitive to executive control. CLOX2 is a copied version that is less dependent on executive skills. In a sample of persons with AD and healthy elderly retirees, we recently demonstrated, using multivariate regression models, that an executive measure (The Executive Interview [EXIT25]) accounted for 68% of CLOX1 variance (Royall, Cordes, & Polk, 1998). In contrast, the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) accounted for 74% of CLOX2 variance. The pattern of performance on CLOX subscales discriminates persons with AD from elderly controls (83.1% of cases correctly classified; Wilkes' lambda = 0.48, $p < .001$) and between AD subgroups with and without constructional impairment (91.9% of cases correctly classified; Wilkes' lambda = 0.31, $p < .001$). In a second sample of healthy elderly retirees ($N = 196$), we found that both the EXIT25 and CLOX1, but neither the MMSE nor CLOX2, made significant independent contributions to the number of categories achieved on the Wisconsin Card Sorting Task (WCST; Royall, Chiodo, & Polk, 1997).

Aside from the CLOX, we know of no other CDT that has been compared to executive measures, and only one study has made comparisons between individual CDTs (Brodaty & Moore, 1997). In the present study, we compare six published CDT scoring systems to one another, as well as to a measure of ECF (the EXIT25; Royall et al., 1992).

Participants

Eighty-five participants were examined (Table 2), including 33 persons with AD (mean age = 73.1 ± 8.9 years) and 52 healthy elderly controls (mean age = 77.0 ± 3.9 years). The AD participants were outpatients diagnosed with probable AD using National Institute of Neurological Communicative Disorders and Stroke (NINCDS) criteria (McKhann et al., 1984). Each received a history, a physical exam, a mental state exam, neuropsychological testing, and a functional status evaluation. Clinical data were confirmed by family members/primary caregivers. All pertinent laboratory results and neuroimaging studies were reviewed.

The control sample consisted of 52 volunteers recruited from the independent living apartments of a large retirement community. All were free of self-reported ADL impairment, stroke, or depression. Moreover, we required that they also score better than 1.0 standard deviation below the unadjusted raw mean for 20–34-year-olds, on both verbal *and performance* subscales of the Weschler Adult Intelligence Scale (WAIS-R; Wechsler, 1981). Informed consent was obtained prior to the evaluation of all participants.

Table 1. CDT Characteristics

Method	Characteristic: Unprompted	Copy	Circle Provided	Time Set
CLOX	+	+	–	1:45
Schulman	+	–	+	11:10
Sunderland	+	–	–	2:45
Rouleau	+	+	+	11:10
Mendez	+	–	–	11:10
Manos	+	–	+	11:10

Notes: + indicates characteristic is present; – indicates characteristic is absent.

Table 2. Subject Characteristics

Measure	Controls (n = 52)	AD (n = 33)
Age (years)	77.0 (3.9)	73.1 (8.9)
Education (years)	15.9 (2.4)	13.3 (3.6)
% Female	51%	65%
EXIT25	11.3 (4.5)	23.7 (9.3)
MMSE	28.8 (1.4)	16.1 (6.8)
CLOX1	11.6 (2.8)	5.7 (4.8)
CLOX2	14.0 (1.2)	7.9 (5.6)
Shulman	2.8 (1.6)	4.9 (1.6)
Sunderland	7.3 (2.9)	3.8 (3.1)
Rouleau	7.2 (2.5)	3.2 (3.2)
Mendez	16.2 (3.7)	7.8 (7.0)
Manos	7.2 (3.2)	2.9 (3.8)

Notes: Group means for all variables differ by ANOVA (all $p < .01$). Values are means (standard deviations) unless otherwise indicated.

Material and Procedures

All participants were instructed to draw a clock according to the method of Royall, Cordes, and Polk (1998). This provided a standardized set of verbal instructions, an unprompted clock, and a copied clock. Both clocks were set to 1:45 and were scored by a single examiner (A.R.M.). The copied clock (CLOX2) was scored according to the scoring system of Royall, Cordes, and Polk (1998).

The unprompted clock was scored according to six published CDT-scoring systems (Manos & Wu, 1994; Mendez et al., 1992; Rouleau et al., 1996; Royall, Cordes, & Polk, 1998; Shulman et al., 1993; Sunderland et al., 1989). However, we adapted the instructions for most of these systems to accommodate a 1:45 setting. To ensure reliability of these changes, 20 unprompted clocks (10 demented participants and 10 healthy elderly controls) were rescored by a second blind examiner (D.R.R.). Interrater reliability was high (ranging from $r = .96$ to $r = 1.0$, all $p < .001$). Descriptions of each original CDT and our adaptations are presented below and examples of the scores obtained by each scoring system are presented in Figure 1.

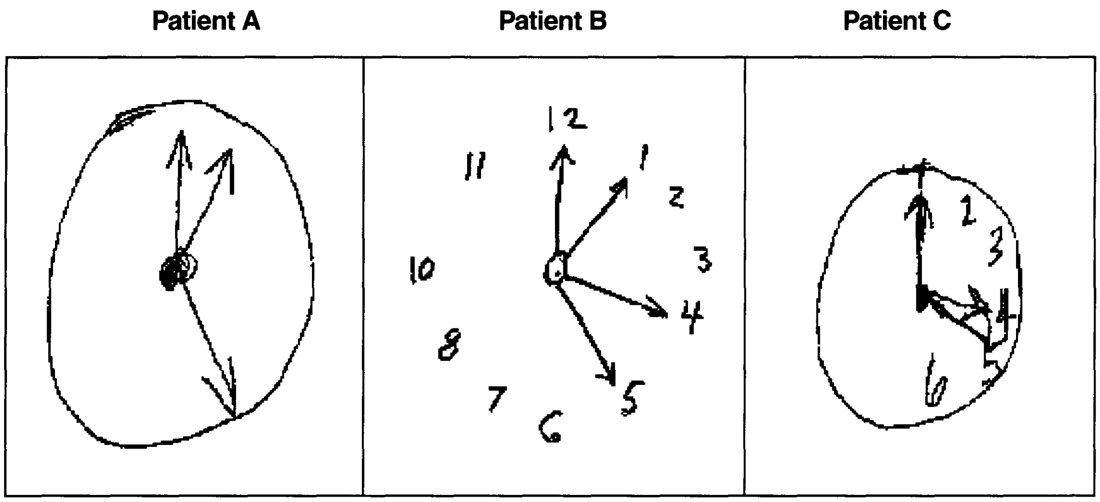
The participants were also rated on the following outcome measures: The EXIT25, a measure of ECF (Royall et al., 1992), and the MMSE.

Instruments

Clock drawing tests.—CDTs vary with regard to their recommended time settings. However, for the purposes of this study, all CDTs were set to 1:45. Usually, this required little alteration of the CDTs' original grading. For example, Manos (see below for definitions of tests) deducts points for "incorrect hand placement." This is easily accommodated.

In contrast, some CDTs anticipate specific errors associated with hand placement. Thus, Rouleau and Schulman deduct points for hands set to "10:50" rather than "11:10." This error reflects "stimulus bound behaviors." Stimulus bound errors have been associated with left frontal cortical lesions and are relevant to ECF failure. However, this class of error is not limited to clocks set to "11:10." Figure 1 presents several CLOX productions that show this type of error in the context of a 1:45 setting. Moreover, CLOX provides opportunities to observe this phenomenon that are independent of the time to which the clock has been set (Figure 2). Specific errors related to hand placement were graded against 1:45, rather than the original CDT's setting.

CLOX: An Executive Clock-Drawing Task (Royall, Cordes, & Polk, 1998).—CLOX has been divided into two parts to help discriminate the executive control of clock drawing from drawing per se. The participant is first asked to draw a clock on a blank page. He or she is instructed only to "Draw a clock that says 1:45. Set the hands and numbers on the face so that a child could read them." Once the individual begins to draw, no further assistance is allowed. The participant's performance is rated on a 15-point scale (lower scores indicate impairment) and is scored as CLOX1. CLOX2 rates the participant's performance in a copy condition. Cut-points of 10/15 (CLOX1) and 12/15 (CLOX2) represent the 5th percentile for young adult controls.



CDTs	Patient A	Patient B	Patient C
CLOX1	5 (15)	5	6
Manos	0 (10)	6	1
Mendez	7 (20)	12	12
Rouleau	2 (10)	3	3
Shulman	5 (6)	4	4
Sunderland	3 (10)	5	4

Figure 1. CDT Score Comparisons. (Numbers in parentheses represent highest possible scores.)

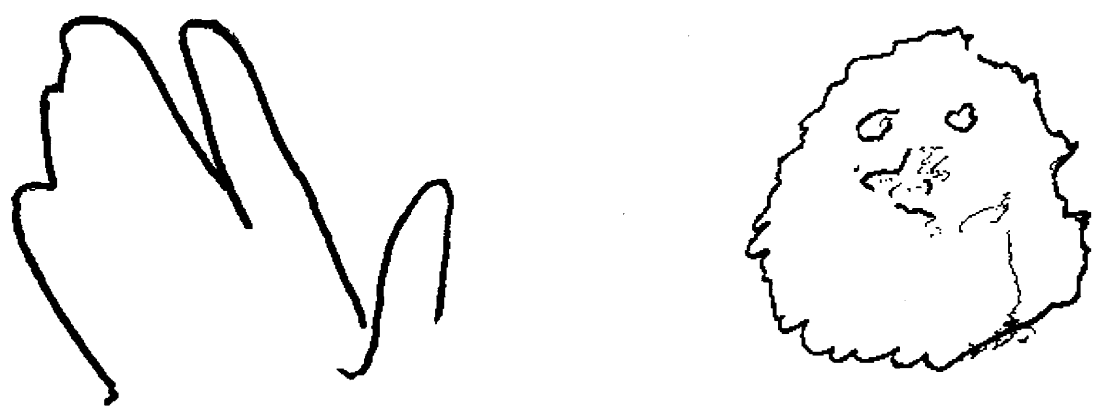


Figure 2. Stimulus Bound Errors related to the CLOX instruction to "set the hands and numbers on the face."

Manos (Manos & Wu, 1994).—The Manos CDT instructs the participant to draw a clock using a predrawn circle in an unprompted condition. Participants are instructed, "Put the numbers in the face of a clock and make the clock say ten minutes after eleven." A 10-point scale is used to rate the performance, with lower numbers reflecting greater cognitive impairment. For the purposes of this study, a predrawn circle was not used.

Mendez (Mendez et al., 1992).—The Mendez CDT asks participants to draw a clock set to 11:10 on a blank piece of paper in an unprompted condition. The instructions are given orally and in writing and are repeated as necessary. A 20-point scale is used, with lower scores reflecting greater impairment.

Rouleau (Rouleau et al., 1996).—The Rouleau CDT instructs participants to draw a clock on a blank piece of paper in an unprompted condition. Subjects are told, "I would like you to draw a clock, put in all the numbers, and set the hands for ten after eleven." The participants are also asked to copy a clock. This CDT is designed to identify the quantitative and qualitative aspects of cognitive impairment in patients with AD. A 10-point scale is used, with lower scores reflecting greater cognitive impairment. For the purposes of this study, the qualitative analyses of this CDT were not employed.

Shulman (Shulman et al., 1993).—The Shulman CDT uses both a predrawn circle and unprompted conditions. Participants are told, "Put the numbers on the clock and set the time to ten after eleven." A 6-point scale is used, with higher scores reflecting greater cognitive impairment.

Sunderland (Sunderland et al., 1989).—The Sunderland CDT instructs participants to draw a clock on a blank piece of paper in an unprompted condition. Participants are told, "First draw a clock with all the numbers on it. Second, put the hands on the clock to make it read 2:45." These instructions are repeated as necessary, and there is no time limit. A 10-point scale is used, with lower scores reflecting greater cognitive impairment.

Outcome Measures

The Executive Interview (EXIT25; Royall et al., 1992; Othmer & Othmer, 1994).—EXIT25 provides a standardized clinical ECF assessment. It contains 25 items designed to elicit signs of frontal system pathology (e.g., imitation, intrusions, disinhibition, environmental dependency, perseveration, frontal release). It takes 15 minutes to complete and can be administered by nonmedical personnel. Interrater reliability is high ($r = .90$). EXIT25 scores range from 0 to 50, with higher scores signifying impairment. EXIT25 correlates well with other measures of ECF including the WCST ($r = .54$), Trail Making Part B ($r = .64$), Lezak's Tinker Toy test ($r = .57$), and the Test of Sustained Attention (Time, $r = .82$; Errors, $r = .83$). EXIT25 scores are reported to correlate strongly and specifically with mesio-frontal cerebral blood flow (rCBF) by Single Photon Emission Computerized Tomography (SPECT; Jobe et al., 1996). A cut-point of 15/50 is recommended. This best discriminates healthy from demented elderly adults and between individuals with and without significant IADL impairment. An EXIT25 score of 10/50 represents the 5th percentile for young adults and best discriminates subjects with mesio-frontal SPECT rCBF deficits from young adult controls.

Mini-Mental State Examination (MMSE; Folstein et al., 1975).—The MMSE is a well-known and widely used test for screening cognitive impairment. Scores range from 0–30, with scores below 24 reflecting cognitive impairment. In these analyses, the MMSE is used as a proxy for posterior cortical pathology. It has no items that are specifically addressed to ECF (Folstein, 1998), and it may underestimate cognitive impairment in the absence of posterior cortical pathology (Royall, 1997; Royall & Polk, 1998).

Results

The participants with AD differed from healthy elderly controls on all CDTs and bedside measures (by ANOVA: $df(1,85)$ all $p < .001$; Table 2). These differences persisted after adjusting for age, gender and education (by MANOVA: $df(1,68)$, all $p < .001$).

Age and education correlated significantly with some CDT and outcome measures. Age correlated significantly with Mendez ($r = -.24$, $p = .05$) and Sunderland ($r = -.24$, $p = .05$). Education correlated significantly with EXIT25 ($r = -.30$, $p = .01$), MMSE ($r = .34$, $p < .05$), CLOX1 ($r = .24$, $p = .05$), Manos ($r = .24$, $p < .05$), and Rouleau ($r = .27$, $p = .02$). Age and education were therefore retained in subsequent multivariate regression models.

All CDTs correlated significantly with both EXIT25 and MMSE scores (Table 3). CDTs' associations with EXIT25 generally persisted in multivariate regression models, even after adjusting for age, education, and MMSE scores (all CDT βs significant at $t(66)$, $p \leq .05$, except Manos and Schulman). We used backwards stepwise linear multivariate regression to test the CDTs' relative contributions to variance in EXIT25 scores. This iterative procedure sequentially rejects the variable that explains the least variance in the outcome measure, independent of the variables remaining in the model. Only CLOX1 ($\beta = -.51$, $t(69) = -5.4$, $p < .001$) and CLOX2 ($\beta = -.39$, $t(69) = -4.1$, $p < .001$) made significant independent contributions (Table 4). Together, they explained 68% of EXIT25's variance, $F(2,69) = 73.5$, $p < .001$, $R^2 = .68$. CLOX1 accounted for 88% of this ($R^2 = .60$). In contrast, CLOX2 contributed most to the variance in MMSE scores (by backwards stepwise linear regression: CLOX2 $\beta = .52$, $t(68) = 5.9$, $p < .001$; CLOX1 $\beta = .40$, $t(68) = 4.5$, $p < .001$. No other variables were retained). Together, CLOX2 and CLOX1 explained 72% of the MMSE's variance, $F(2,68) = 87.1$, $p < .001$, $R^2 = .72$.

Discussion

We found that all six CDT scoring systems correlated strongly and significantly with EXIT25. These associations generally persisted after adjusting for age, education, and MMSE scores. This is consistent with both Gruber, Varner, Chen, and Lesser's (1997) suggestion that CDTs draw upon an

Table 3. Correlation Matrix

	CLOX1	CLOX2	Shulman	Sunderland	Rouleau	Mendez	Manos
CLOX2	.69						
Shulman	–.73	–.50					
Sunderland	.88	.56	–.79				
Rouleau	.86	.67	–.75	.83			
Mendez	.95	.70	–.76	.88	.88		
Manos	.85	.51	–.74	.87	.82	.86	
EXIT25	–.78	–.74	.56	–.63	–.69	–.73	–.57
MMSE	.76	.80	–.57	.60	.69	.75	.62

Note: All *p*s < .001.

Table 4. Backwards Stepwise Regression Model of CDTs vs EXIT25

Variable	Step[a]	Multiple R^2	R^2 change	F	p
All Variables		.7192			
Rouleau	−1	.7162	−.003	0.07	ns
Sunderland	−2	.7154	−.000	0.18	ns
Mendez	−3	.7138	−.002	0.35	ns
Age	−4	.7128	−.001	0.23	ns
Schulman	−5	.7111	−.002	0.39	ns
Manos	−6	.6953	−.016	3.67	ns
Education	−7	.6807	−.015	3.26	ns
CLOX2	**8**	**.6016**	**.079**	**17.08**	**< .001**
CLOX1	Final	—	**.6016**	**105.70**	**< .001**

Notes: Variables in bold type were retained, $F(2,69) = 73.5$, $p < .001$; $R^2 = .68$.

[a]Variables with (−) steps were ejected from the model; variables with (+) steps were retained.

executive skills component, and our own impression that clock drawing is best considered as a complex behavior that is dependent on executive control (Royall, Cordes, & Polk, 1998).

The relative "executiveness" of the six scoring systems we compared can be estimated by the order in which they were rejected from the backwards regression model presented in Table 4. This model suggests that performance on Rouleau's CDT explains the least independent variance in ECF (as measured by EXIT25). CLOX 1 explains the most. No CDT, except CLOX2, adds significant independent variance to that explained by CLOX1 (Table 4). All other variables combined add only 10% of additional EXIT25 variance to CLOX1.

However, it is important to recognize that an individual CDT's sensitivity to ECF impairment may also depend on subtle differences in the methods of their presentation. Our decision to score these CDTs off a common stimulus limits our ability to draw conclusions regarding CLOX's methodology relative to the others. There may yet be unmeasured variance in ECF due to the verbal or nonverbal patient/examiner interactions that were lost.

Our decision to adapt the other CDTs to CLOX's instruction set may have affected their performance in other ways. Specifically, there may be concerns that our adaptations limit the ability of other CDTs to score stimulus bound responses. We do not believe this to be the case. Figures 1 and 2 demonstrate that our hand placement provides ample opportunities to observe this class of errors. In fact, stimulus bound errors are even more impressive under our grading system because, unlike an 11:10 versus 10:50 confusion, they are impossible to misconstrue.

Of the CDTs we surveyed, only Rouleau and Shulman specifically anticipate stimulus bound responses in their grading (although the others may in fact provide opportunities to observe this phenomenon). Shulman considers this a "minor error." In contrast, the CLOX grading was specifically designed to anticipate the type of difficulties presented above, and it deducts points for both the hands set inappropriately to the 4 and 5 o'clock positions (e.g., item 15), and in some cases, the use of a third hand (item 11) required to do so (Figure 1).

Another potential limitation to this study is that there may be aspects of ECF to which EXIT25 is not sensitive. ECF is associated with three significant frontal systems—mesiofrontal, orbitofrontal, and dorsofrontal—which together comprise 40% of the brain's weight and surface area (Cummings, 1993). Although EXIT25 is significantly associated with several formal ECF measures, it seems very unlikely that any single measure can measure ECF comprehensively.

In fact, EXIT25 scores are reported to correlate strongly and specifically with mesiofrontal cerebral blood flow (rCBF) by SPECT (Jobe et al., 1996). This is significant. Although frontal AD pathology generally correlates better with general cognitive measures than either hippocampal or temporal lobe pathology (DeKosky & Scheff, 1990; Neary et al., 1986; Terry et al., 1991), *mesiofrontal* synaptic density is the strongest known pathological correlate of global cognitive test performance in AD. Moreover, AD affects the frontal systems in a predictable sequence: mesiofrontal (marked by EXIT25) > orbitofrontal > dorsofrontal (marked by the WCST; Braak & Braak, 1994; De Lacoste & White, 1993; Delacourte, 1998; Delacourte et al., 1998). This suggests that EXIT25 may prove to be both a strong predictor of global dementia severity in AD and a sensitive measure of its earlier manifestations. It is a strong predictor of level of care among elderly retirees as well (Royall, Cabello, & Polk, 1998). EXIT25's proxies, including CLOX, may share these characteristics (Royall, Chiodo, & Polk, in press). Interestingly, CLOX1 has been found to be a significant predictor of the Life-Space Questionnaire, a measure of autonomy, among community-dwelling elderly persons (Pearson $r = .53$, $p < .001$; Grace, Baker, & Allman, 1999). This association persists after adjusting for age, gender, education, vision, income, depression ratings, MMSE, and Mental Status Questionnaire scores.

However, these results should not be interpreted to mean that the earlier CDTs are insensitive to ECF. Even the weakest correlation we observed between EXIT25 and a CDT was significant (Shulman $r = .56$). Some CDTs, particularly Mendez, would probably perform indistinguishably from CLOX in practice. Instead, we wish to emphasize clock drawing's inherent executiveness. This aspect of clock drawing has not received much attention in the past, perhaps because of the CDT's apparent face validity as a constructional task. The generally robust associations between these six CDTs and a measure of ECF raises the still more interesting possibility that some tests of "language" and "memory" may be vicariously sensitive to ECF as well.

In summary, clock drawing draws upon executive as well as constructional cognitive resources. This suggests that CDTs represent a potentially easy, reliable, and cost-effective means of measuring ECF. Subtle differences in clock-drawing scoring systems may affect their performance as executive measures. CLOX1 may have an incremental advantage over other CDTs in this regard. This relationship between executive function and specific cognitive skills may apply to tests of other domains as well.

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The authors wish to acknowledge the cooperation and support they received from the Air Force Villages. Address correspondence and requests for detailed information regarding the CLOX to Dr. Donald Royall, Department of Psychiatry, The University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78284-7792. E-mail: royall@uthscsa.edu

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Administration of the CLOX: Clock Drawing Executive Test ©Royall, 1998

There is a growing interest in the potential of clock-drawing tests (CDT) as a screen for cognitive impairment. CDT's have been found to correlate significantly with traditional cognitive tests and to discriminate healthy from demented elderly patients. The severity of clock-drawing failures progresses over time in Alzheimer's disease (AD), and correlates with longitudinal changes in cognitive testing. Moreover, CDTs are rapid and well accepted by both patients and clinicians.

We are specifically interested in clock-drawing's ability to measure executive control function (ECF). ECFs are cognitive processes that coordinate simple ideas and actions into complex goal directed behaviors. Examples include goal selection, motor planning sequencing, selective attention, and the self-monitoring of one's current action plan. All are required for successful clock-drawing.

It is important to measure ECF because executive impairment is strongly associated with functional disability as well as with many significant illnesses, including Alzheimer's disease (AD), major depression, multiple sclerosis, Parkinson's disease and schizophrenia. Unfortunately, few bedside cognitive measures have been designed to assess ECF directly, and formal ECF tests are seldom practical for routine use in clinical settings.

This manual describes a CDT (CLOX: An Executive Clock-drawing Task) that has been specifically designed to elicit executive impairment and discriminate it from nonexecutive constructional failure.

The Executive Clock-Drawing Task (CLOX):

The CLOX has been divided into two parts to help discriminate the executive control of clock-drawing from clock-drawing per-se. The patient is first instructed to draw a clock on the back of the CLOX form (see pdf file). He or she is instructed only to "Draw me a clock that says 1:45. Set the hands and numbers on the face so that even a child could read them." The instructions can be repeated until they are clearly understood, but once the subject begins to draw no further assistance is allowed. The subject's performance is rated according to the CLOX, directions, and scored as "CLOX 1".

CLOX 1 reflects the patient's performance in a novel and ambiguous situation. He or she is presented only with a blank surface and no further guidance regarding the task. The patient is responsible for choosing the clock's overall form (a digital or analog face, alarm clock, wristwatch or wall clock, etc.), it's size, position on the paper, elements (hands, numbers, date indicators), the forms of these elements (hands as arrows, relative lengths, Roman vs. Arabic numerals, etc.). Furthermore, the patient must also initiate and persist in clock-drawing through a sequence of constructional actions (usually drawing the outer circle, followed by placing the numbers if any, followed by setting the time). Finally, he or she must monitor their progress as the task unfolds, both anticipating (placing the **12, 6, 3**, and **9** first) and/or correcting errors as they occur.

It is just as important to note what a patient *does not do* during a clock-drawing task. Our CLOX form and its verbal instructions have been designed to tempt the patient into, strongly associated but irrelevant behaviors. The circle in the left lower corner is irrelevant to clock-drawing when viewed from the back side of the form, but it tempts the patient to place their clock within its image. We chose the words "hand" and "face because they are more strongly associated with body parts than clock elements, and may trigger semantic intrusions from their more common meanings. The number **"4'5"** does not appear on a typical clock face, and may intrude into the patient's construction in the form of a digital image **(1:45)** or hands pointing to the **4** or **5** o' clock positions. Of the **15** available CLOX points, **13** rate the presence of subject chosen elements. Three points reflect the inhibition of irrelevant distractions, the anticipation of potential spacing errors, and their monitoring or correction. CLOX scores range from **0-15**. Lower scores. reflect greater impairment.

The CLOX's second step is a simple copying task. The examiner allows the patient to observe him or her drawing a clock in the circle provided on the scoring sheet. The examiner sets the hands again to **"1:45",** places the **12,6,3,** and **9** first, and makes the hands into arrows. The patient is allowed to copy the examiner's clock. Score this clock as "CLOX **2**".

CLOX: An Executive Clock Drawing Task©

STEP 1: Turn this form over on a light colored surface so that the circle below is visible. Have the subject draw a clock on the back. Instruct him or her to "**Draw me a clock that says 1:45. Set the hands and numbers on the face so that a child could read them.**" Repeat the instructions until they are clearly understood. Once the subject begins to draw no further assistance is allowed. Rate this clock (CLOX 1).

STEP 2: Return to this side and let the subject observe you draw a clock in the circle below. Place 12, 6, 3, & 9 first. Set the hands again to "1:45". Make the hands into arrows. Invite the subject to copy your clock in the lower right corner. Score this clock (CLOX 2).

RATING			
Organizational Elements	**Points**	**CLOX 1**	**CLOX 2**
Does figure resemble a clock?	1		
Outer Circle Present?	1		
Diameter >1 inch?	1		
All numbers inside the circle?	1		
12, 6, 3, & 9 placed first?	1		
Spacing Intact? (Symmetry on either side of the 12-6 axis?) If "yes" skip next.	2		
If spacing errors are present, are there signs of correction or erasure?	1		
Only Arabic numerals?	1		
Only numbers 1 - 12 among the Arabic numerals present?	1		
Sequence 1-12 intact? No omissions or intrusions.	1		
Only two hands present?	1		
All hands represented as arrows?	1		
Hour hand between 1 and 2 o'clock?	1		
Minute hand longer than hour?	1		
None of the following 1) hand pointing to 4 or 5 o' clock?	1		
2) "1:45" present?			
3) intrusions from "hand" or "face"?			
4) any letters, words or pictures?			
5) any intrusion from circle below?	TOTAL