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Ecological Validity and the Measurement of Executive Functioning in Children

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Presidential Address

Presentation Overview: Objectives

1. to explain the challenge of measuring executive functioning in children
2. to describe the differences between measurement of executive functioning using performance-based tests vs. rating scales
3. to describe at least one methodology that could be used to increase ecological validity of executive functioning measurement

Definition of Executive Functioning

"those mechanisms by which performance is optimized in situations requiring the simultaneous operation of a number of different cognitive processes" (Baddeley, 1986)

Definition of Executive Functioning

a set of behaviors that allows a person to attain a desired goal

Goals might be:

- getting to work in the morning
- finishing a report when your computer freezes

Goals for children might be:

- getting a book report written by the deadline
- avoiding a fight with a bully at school

Executive functioning (this concept was first applied to adults' complex functioning)

includes many cognitive elements:

- Allocation of attention
- Concept formation
- Planning
- Inhibition of inappropriate responses
- Working memory
- Self-monitoring
- Flexibility of thought

Executive functioning

also includes:

- Behavioral self-regulation

Historical context: EF is a cognitive function, so EF occurs in the brain

the frontal lobes are involved although frontal regions are only part of the circuitry

executive dysfunction is a frontal "thing"

What is executive functioning in children?

old idea –

kids don't have "frontal lobe functions"

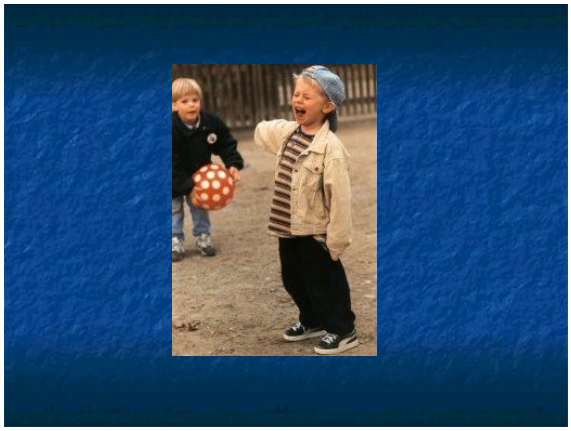
Oh yeah????

Let's suppose a 5-year-old wants a toy -- is he/she capable of:

focusing attention ?

using a strategy ?

following the plan ?



EF is a part of cognitive development and it improves as children grow up.

For example:

Even young children can direct their attention but may not have good impulse control

Older children may have some impulse control but may not be able to consider multiple action plans simultaneously

Why is EF important in child assessment?

Many developmental conditions and acquired disorders result in executive dysfunction

e.g., ADHD, traumatic brain injury

Why is EF important in child assessment?

We need to determine the nature and degree of problems with EF that a child may have,

for the purpose of treatment planning and environmental modifications

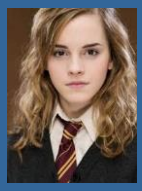
So… executive dysfunction can take many forms

- Failing to think before acting
- Failing to anticipate the consequences of one's actions
- Failing to benefit from experience and failing to choose good strategies

So… executive dysfunction can take many forms

- Failing to plan and follow reasonable steps to accomplish something
- Failing to keep track of possessions
- Failing to keep track of one's own progress on a task

Who has executive dysfunction?

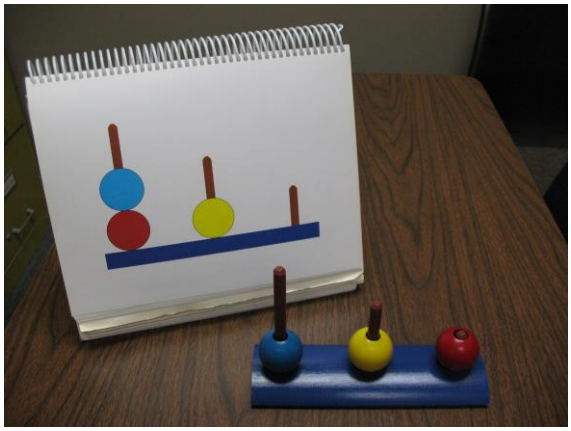


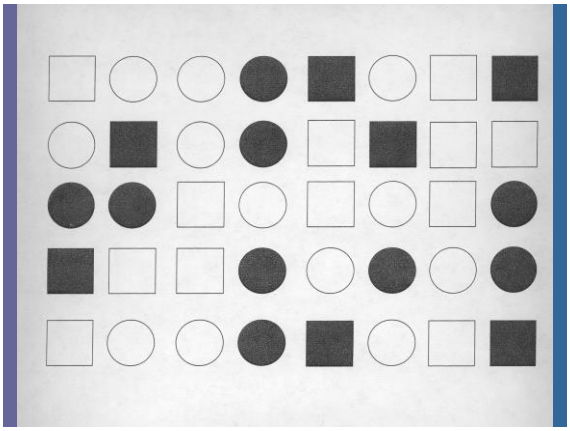
Who has executive dysfunction?

Who has executive dysfunction?

How do we test executive functioning?

- reasoning tests of various kinds
- tests of impulse control or inhibition





Benefits of neuropsychological tests

- Designed to measure discrete functions
- Allow measurement in controlled environment without distractions, social pressure, general stress

Let's pretend we've given these tests to Harry

What do you think?

- Allocation of attention
- Concept formation
- Planning
- Working memory
- Self-monitoring
- Flexibility of thought

Ecological Validity – the general question:

How well can test results predict functioning in the real world?

Ecological validity of neuropsychological tests?

- Designed to measure discrete functions
- Allow measurement in controlled environment without distractions, social pressure, general stress

… but is this like behavior in the real world?

Ecological Validity of EF

"Test scores are reductionistic symbolic representations of real events and as real events become more complex, interactive, and dynamic, the reductionistic symbols become a poorer representation of the reality" (Cripe, 1996)

The challenge of measurement…

How SHOULD we measure executive functioning?

long history of relying upon parents to give us characteristics of their children's behavioral functioning

- why not borrow the parent rating scale technique to measure EF?

Behavior Rating Inventory of Executive Function (BRIEF) (Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L., 2000)

Behavioral Regulation Index

Inhibit Shift Emotional Control

Metacognitive Index

Initiate Working Memory Plan/Organize

Organization of Materials Monitor

Global Executive Composite

BRIEF - Sample items

Plan/Organize:

Does not plan ahead for school assignments

Inhibition:

Has trouble putting the brakes on his/her actions

Working Memory:

Has trouble with chores or tasks that have more than one step

Let's give the BRIEF to the Dursleys

Remember what the Dursleys' values were?

They liked things tidy & predictable & logical

Mr. Dursley didn't approve of imagination

They thought Harry was abnormal

Hint: Parents may endorse the presence of specific behaviors as a function of global attributions (De Los Reyes & Kazdin, 2005)

… an abnormal kid… nothing but trouble…

According to the Dursleys…

What is Harry's

Global Executive Composite?

It's significantly elevated because it reflects all of his "troublesome" behaviors!

Food for thought - what if we gave the teacher version of the BRIEF to Dumbledore?

Returning to the discrepancy between how Harry might do on tests and how the Dursleys might rate him --

Let's consider some actual data --

Toplak, West, & Stanovich, 2013

Pubmed and *PsyInfo* reviewed for studies that examined the relationship between performance-based and ratings-based measures of EF

Outcome: 20 studies

13 involved children, 7 involved adults

7 used clinical samples, 2 used nonclinical samples, 11 used combined samples

16 reported correlation coefficients, 4 simply reported that all relationships were nonsignificant

Toplak, West, & Stanovich, 2013

Summary of the 20 studies:

286 correlations were calculated

24% of the comparisons were statistically significant (68 / 286)

median correlation coefficient = 0.19

Authors' first comments:

"surprising lack of association"

Principle of convergent validity = different measures of the "same" construct should correlate highly

BRIEF x Continuous Performance Tests

Authors expected positive relationship between commission errors on Conners CPT-II & parent report of inhibition problems on the BRIEF

Participants: mixed clinical sample (*n* = 109)

Results:

Comm errors x BRIEF Inhibition *r* = -.12

Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007

BRIEF x Tower of London, Verbal Fluency Test

Participants: children with frontal circuitry pathology & control group (*n* = 189)

Results:

VF x BRIEF Working Memory *r* = .30
VF x BRIEF Inhibit *r* = .29
VF x BRIEF Emotional Control *r* = .24
TOL – no significant correlation with BRIEF

Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002

BRIEF x Behavioral Assessment of Dysexecutive Functions for Children (BADS-C)

Participants: children with & with/out ADHD (*n* = 50)

Results:

BADS-C Total x BRIEF GEC *r* = -.36
BADS-C Total x BRIEF Metacog *r* = -.37
BADS-C Total x BRIEF BRI *r* = -.25
BADS-C Total x BRIEF Plan scale *r* = -.46

Shimoni, Engel-Yeger, & Tirosh, 2012

BRIEF x Delis-Kaplan Executive Function System

Participants: children with epilepsy & controls (*n* = 103)

Results:

Sorting test x BRIEF Metacog *r* = -.28
Sorting test x BRIEF BRI *r* = -.24

Verbal fluency x BRIEF Metacog *r* = -.32
Verbal fluency x BRIEF BRI *r* = -.16

Color-Word x BRIEF Metacog *r* = -.33
Color-Word x BRIEF BRI *r* = -.11

Parrish, Geary, Jones, Seth, Hermann, & Seidenberg, 2007

Children's Executive Function Scale (CEFS) x Tower of London, Wisconsin Card Sorting Test

Participants: mixed clinical & nonclinical sample (*n* = 59)

Results:

TOL Total x CEFS Total *r* = -.13
TOL Broken Rules x CEFS Total *r* = .35
WCST Cat Completed x CEFS Total *r* = -.30
WCST Persev Resps x CES Total *r* = .31

Goulden & Silver, 2009

Childhood Executive Functioning Inventory (CHEXI) x computerized EF battery including Go No-Go, Stroop-like, working memory (word span) tasks

Participants: nonclinical preschool sample (*n* = 844)

Results:

EF tasks summ x CHEXI Working Memory *r* = -.10
EF tasks summ x CHEXI Inhibit *r* = -.05

Note: EF tasks x beh obs "in the moment" *r* = .50

Camerota, Willoughby, Kuhn, & Blair, 2018

The Next Step ---

So, published data show very low agreement between what tests say and what parents say about children's EF.

What should neuropsychologists do to get accurate measurement of children's EF?

Reasons for the disagreement

Testing situation is too structured, too fractionated

Testing situation is artificial

Test demands upon abilities are too specific

So, is parent-report more valid?

Reasons for the disagreement

EF in the real world is messy, is contaminated by environmental factors

Parents' perceptions are subjective

So, are performance-based tests more valid?

So here we are…

Neuropsychologists cannot simply ignore one source of information.

Neuropsychologists cannot report both findings without explanation if they contradict!

Neuropsychologists need to know how to interpret the disagreement – which finding applies when?

The nature of the differences?

More children were seen as impaired on the BRIEF than on the performance-based tests

Vriezen & Pigott, 2002

More children were seen as impaired on the BRIEF than CPT

Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007

Let's bypass the accuracy question –

Consider an integrated, multi-method approach advocated by many experts

Ecological validity

Seems reasonable to say:

Performance-based results tell us about a child's EF

- under optimal circumstances
- component by component
- when structure is provided

Ecological validity

Seems reasonable to say:

Parent ratings tell us about a child's EF

- in the presence of environmental demands
- when variable or little structure is provided
- in terms of integrated or holistic functioning

Clinical interpretation

The two sources of information may tell us…

the optimal level of functioning of which the child is capable **in the specific test domain**, given that other domains of EF are being structured for the child, **as contrasted with** the level of functioning the child displays when dealing with environmental complexities.

Interpretation for intervention

We can use that information to tell us in what situations parents and teachers may need to control or adapt the environmental complexities to help the child use his/her best abilities.

Ecological validity

One step farther…

Could we integrate the two sources of information even better?

Perhaps investigate the relationship between performance-based tests and parent ratings of EF and explore the parameters of that relationship?

Can we determine a way to explain or predict the relationship between the two sources of information?

-- mediating variables?

Here's a mediating variable -

From previous research on parent ratings of their children's behavior problems:

If the parent is depressed, more problems are reported

De Los Reyes & Kazdin, 2005; Treutler & Epkins, 2003; Youngstrom, Loeber, & Stouthamer-Loeber, 2000

Perhaps if parents are stressed-out, more difficulties with *executive functioning* are reported

Stress → ratings of child executive dysfunction

Participants: 32 children with ADHD

Results –

- *r* = .58 for BRIEF Total score x total stress
- *r* = .71 for BRIEF Total score x child domain
- *r* = .31 for BRIEF Total score x parent domain

Joyner, Silver, & Stavinoha, 2009

Stress → ratings of child executive dysfunction

Participants: 32 children with ADHD

Results –

- *r* = .72 for CEFS Total score x total stress
- *r* = .70 for CEFS Total score x child domain
- *r* = .51 for CEFS Total score x parent domain

Joyner, Silver, & Stavinoha, 2009

How interesting…

Are the parents biased?

Or are the children misbehaving?

Perhaps the child behaviors are *creating* the stress

… seems like a good place to continue looking

Returning to Toplak, West, & Stanovich, 2013

After reviewing studies that examined the relationship between performance-based and ratings-based measures of EF…

They suggest that each method assesses different aspects of cognitive and behavioral functioning that contribute independently to clinical problems

They are tapping into two different cognitive levels:

- Algorithmic (efficient cognitive mechanisms)
- Reflective (rational goal pursuit)

Another way to say it…

Cognitive tasks are designed to measure cognitive dysfunction, whereas questionnaires assess the CONSEQUENCES of the dysfunction in daily life.

De Vries, de Ruiter, Oostrom, Schouten-Van Meeteren, Maurice-Stam, Oosterlaan, & Grootenhuis, 2018

Potential methods to improve measurement of EF in children

Report separately and explain?

Look for mediating factors?

Determine algorithms for combining both sources to predict functioning?

EMA?

One final thought - EMA

Ecological Momentary Assessment

In the age of smart phones,

why must we rely upon retrospective reporting of the child's behaviors?

Ecological Momentary Assessment

Electronic diary method

Assessment of behaviors collected "in the moment"

Collected over time and in different settings

As life is lived, day-to-day, in the natural environment

Shiffman, Stone, & Hufford, 2008

More work needs to be done:

- to obtain accurate measurement of EF

- to integrate and explain results of EF assessment

so neuropsychologists can better determine the nature and degree of children's problems with EF and recommend interventions

Thank you for your attention!

Happy Halloween!