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Auditory Processing Disorders: Application and interpretation of SCAN-3 Test Battery

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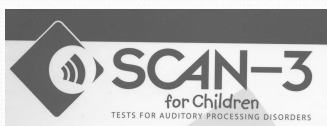
This presentation will review the SCAN-3 Tests of Auditory Processing Disorders. There will include a description of the various tests within the battery, rationale for those tests, scoring procedures, and interpretation of the findings.

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Course Objectives

- participants will be able to describe changes and important features of the SCAN-3: Tests for Auditory Processing Disorders

- participants will be able to identify when it may be appropriate to administer the SCAN-3: Tests for Auditory Processing Disorders

- participants will be able to list what the individual tests within SCAN-3 include

- participants will be able to describe the difference between tests of auditory processing and tests for language disorders

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Development and standardization of SCAN: the grandfather of the SCAN test battery

- Jack Willeford – 1974 Colorado APD test battery
- SCAN background research – literature and student research, 1979-1983
- Proposal to Tom Hutchinson ASHA 1983
  - To develop a well standardized test of auditory processing that could be administered easily with simple equipment in the schools. The subtests included:
    - FW
    - AFG
    - CW
    - ***Binaural Fusion – omitted following standardization study***
- Standardization – 1035 children
- SCAN: A screening test for auditory processing disorders in children – 1986
- SCAN-C: Test for Auditory Processing Disorders in Children – Revised (2000)

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SCAN (Keith, 1986)

- Subtests:
  - Filtered Words - low-pass at 1000 Hz
  - Auditory Figure-Ground at +8 dB S/N ratio
  - Competing Words (25 word pairs each, RE & LE)
  - Binaural Fusion eliminated (beta testing found no difference in performance between children with and without APD)
- Standardization sample:
  - N = 1034
  - 3:0 years to 10:11 years

SCAN
A Screening Test for Auditory Processing Disorders
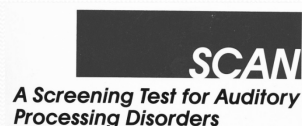
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SCAN-C: Test for Auditory Processing Disorders in Children – Revised (2000)

The next generation SCAN

Introducing

SCAN·C

Test for Auditory Processing Disorders in Children – Revised

Robert W. Keith

THE PSYCHOLOGICAL CORPORATION

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SCAN-C: Test for Auditory Processing Disorders in Children – Revised (2000)

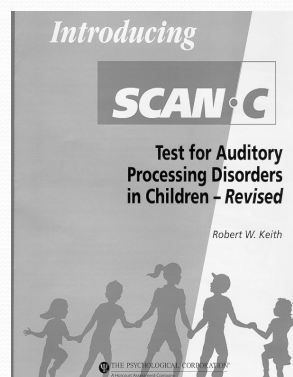- Subtests:
  - Filtered Words - low-pass at 1000 Hz
  - Auditory Figure-Ground at +8 dB S/N ratio
  - Competing Words (25 word pairs each, RE & LE)
  - Competing Sentences (10 sentence pairs, each RE & LE)

  Standardization sample   N = 600
  Test - retest   N = 150
  Construct validity   N = 160
  Reliability   N = 100

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SCAN-A a Test for Auditory Processing Disorders in Adolescents and Adults (Keith, 1994)

- Tests:
  - Filtered Words (500 Hz @ 32 dB/octave)
  - Auditory Figure-Ground (+ 4 dB S/N)
  - Competing Words (15 word pairs each, RE & LE)
  - Competing Sentences (10 sentence pairs each, RE & LE)
- Standardization sample:
  - N = 125
  - ages 12:0 – 50:0 years

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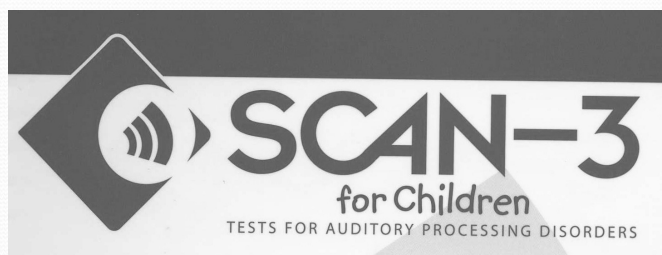
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SCAN–3: for Children

Screening	Diagnostic	Supplemental
Gap Detection Screening Test	Filtered Words 750 Hz Low Pass	AFG +12 dB S/N
AFG +8 dB	AFG +8 dB S/N	AFG 0 dB S/N
Competing Words– Free Recall	Competing Words – Directed Ear	Time Compressed Sentences
	Competing Sentences	

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Why are these tests included?

- FW and AFG are tests of function
  - FW – how well do subjects interpret distorted speech?
  - AFG – how well do subjects hear in the presence of distracting background noise?
- Dichotic tests measure maturation of the auditory system and hemispheric dominance for language. These are developmental measures, and bear no relationship to functional hearing.

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Ear Advantage
Comparison of right and left ear performance

- Necessary to analyze test findings beyond test or composite standard scores
- Results of EA indicate
  - Hemispheric dominance for language
    - Normal left hemisphere dominance
    - Mixed or right hemisphere dominance
  - Presence of possible delay in maturation of or damage to the central auditory pathways
  - Presence of a cortical lesion affecting the auditory reception areas of the brain

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Standardization of SCAN-3 for Children and Adults

- Normative Sample: *n* = 775
  - 525 children ages 5:0 through 12:11
  - 250 adolescents & adults ages 13:0 through 50:11
  - Data collected by 109 speech-language pathologists, audiologists, and psychologists in 32 states
  - Standardization data collected from September 2007 through July 2008

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Summary of the SCAN-3 battery

- Includes screening and diagnostic tests
- Include screening test of temporal processing, AFG, and Dichotic Words
- Filtered Words Test is low-pass at 750Hz
- Auditory Figure Ground tests at three S/N ratios
- Directed ear and free recall response mode for Competing Words
- Four core diagnostic and four supplemental tests
- Provides Ear Advantage prevalence information for all tests
- Normative data for age brackets 5 to 12:11 for children and 13 to 50:11 for adults.

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SCAN-3

for ADOLESCENTS & ADULTS

TESTS FOR AUDITORY PROCESSING DISORDERS

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SCAN-3 for Adolescents/Adults

Screening	Diagnostic	Supplemental
Gap Detection Screening Test	Filtered Words 750 Hz Low Pass	AFG +4 dB S/N
AFG +0 dB S/N	AFG +0 dB S/N	AFG +8 db S/N
Competing Words– Free Recall	Competing Words– Directed Ear	Time Compressed Sentences @ 60%
	Competing Sentences	

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SCAN–3: C Score Summary

Name: _____ ☐ Male ☐ Female
School: _____ Age: _____
Examiner: _____ ☐ SLP ☐ Audiologist ☐ Other
Date of Test: _____

Diagnostic Score Summary

Test	Raw Score	Scaled Score	Scaled Score Points +/−	Confidence Interval ___ % Level	Percentile Rank
AFG +8				___ to ___	
FW				___ to ___	
CW–DE Total				___ to ___	
CS				___ to ___	
Sum of Scaled Scores					
Auditory Processing Composite				___ to ___	

Scaled Score Chart

	AFG +8	FW	CW–DE	CS	CW–FR	AFG +12	AFG 0	TCS	
19	·	·	·	·	·	·	·	·	Normal
18	·	·	·	·	·	·	·	·	
17	·	·	·	·	·	·	·	·	
16	·	·	·	·	·	·	·	·	
15	·	·	·	·	·	·	·	·	
14	·	·	·	·	·	·	·	·	
13	·	·	·	·	·	·	·	·	
12	·	·	·	·	·	·	·	·	
11	·	·	·	·	·	·	·	·	
10	·	·	·	·	·	·	·	·	
9	·	·	·	·	·	·	·	·	
8	·	·	·	·	·	·	·	·	
7	·	·	·	·	·	·	·	·	
6	·	·	·	·	·	·	·	·	Borderline
5	·	·	·	·	·	·	·	·	
4	·	·	·	·	·	·	·	·	
3	·	·	·	·	·	·	·	·	Disordered
2	·	·	·	·	·	·	·	·	
1	·	·	·	·	·	·	·	·	

Supplementary Score Summary

Test	Raw Score	Scaled Score	Scaled Score Points +/−	Confidence Interval ___ % Level	Percentile Rank
CW–FR				___ to ___	
AFG +12				___ to ___	
AFG 0				___ to ___	
TCS				___ to ___	

Ear Advantage Summary

Test	RE Score	−	LE Score	=	EA	Typical		Cumulative Prevalence
AFG +8		−		=		Y	N	If No, ___ %
CW–FR		−		=		Y	N	If No, ___ %
FW		−		=		Y	N	If No, ___ %
CW–DE Directed RE		−		=		Y	N	If No, ___ %
CW–DE Directed LE		−		=		Y	N	If No, ___ %
CS		−		=		Y	N	If No, ___ %
AFG +12		−		=		Y	N	If No, ___ %
AFG 0		−		=		Y	N	If No, ___ %
TCS		−		=		Y	N	If No, ___ %

Note. A positive (+) value = right ear advantage; a negative (−) value = left ear advantage

Behavioral Observations:

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SCAN–3: C Score Summary

Name: *Child Z* ☒ Male ☐ Female
School: *School* Age: *10*
Examiner: *Examiner X* ☒ SLP ☐ Audiologist ☐ Other
Date of Test: ██████████

Diagnostic Score Summary

Test	Raw Score	Scaled Score (A)	Scaled Score Points +/− (B)	Confidence Interval 95 % Level (C)	Percentile Rank (D)
AFG +8	35	6	4	2 to 10	9
FW	34	12	2	10 to 14	75
CW–DE Total	44	11	2	9 to 13	63
CS	60	9	2	7 to 11	37
Sum of Scaled Scores		38			
Auditory Processing Composite (F)		96		88 to 104	39 (G)

Scaled Score Chart

	AFG +8	FW	CW–DE	CS	CW–FR	AFG +12	AFG 0	TCS	
19									Normal
18									
17									
16									
15									
14									
13			X						
12		X							
11									(E)
10									
9	X			X					
8						X	X	X	
7									Borderline
6	X								Disordered
5									
4									
3									
2									
1									

Supplementary Score Summary

Test	Raw Score	Scaled Score (A)	Scaled Score Points +/− (B)	Confidence Interval 95 % Level (C)	Percentile Rank (D)
CW–FR	32	13	2	11 to 15	84
AFG +12	36	8	4	4 to 12	25
AFG 0	25	7	3	4 to 10	16
TCS	54	8	3	5 to 11	25

Ear Advantage Summary

Test	RE Score	−	LE Score	=	EA	Typical		Cumulative Prevalence (I)
AFG +8	17	−	18	=	−1	Y	N	If No, 15 %
CW–FR	16	−	16	=	0	Y	N	If No, ___ %
FW	13	−	16	=	2	Y	N	If No, ___ %
CW–DE Directed RE	14	−	8	=	6	Y	N	If No, 10 %
CW–DE Directed LE	9	−	13	=	−4	Y	N	If No, 5 %
CS	35	−	25	=	10	Y	N	If No, ___ %
AFG +12	18	−	18	=	0	Y	N	If No, ___ %
AFG 0	13	−	12	=	1	Y	N	If No, ___ %
TCS	27	−	27	=	0	Y	N	If No, ___ %

Note. A positive (+) value = right ear advantage; a negative (−) value = left

Behavioral Observations:

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An example of scoring FW test Items

The following slide is an example of how you score the directed ear competing words test and how to determine the ear advantage.

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Directed Right Ear
Practice Items

Right | | Left
a. low | | smile
b. else | | bad

Test Items

1. waste + −	cage + −
2. need + −	case + −
3. may + −	them + −	*men*
4. feed + −	path + −
5. large + −	*hard*	find + −	*fine*
6. feet + −	thank + −
7. dog + −	*thick*	thick + −	*dog*
8. dark + −	hot + −
9. show + −	clown + −
10. race + −	home + −
11. bag + −	day + −	*bay*
12. sell + −	fly + −
13. white + −	get + −
14. dad + −	on + −
15. are + −	*car*	cow + −

Directed Left Ear
Practice Items

Left | | Right
c. is | | put | *pit*
d. true | | great

Test Items

1. most + −	*nose*	ball + −
2. pass + −	seed + −
3. fall + −	*far*	card + −
4. laugh + −	dress + −
5. lay + −	rain + −
6. ride + −	gray + −
7. fire + −	you + −
8. name + −	*same*	bank + −
9. hide + −	knee + −	*need*
10. shake + −	*fake*	car + −
11. wide + −	use + −
12. yes + −	as + −	*ask*
13. mouth + −	*mouse*	grew + −
14. air + −	camp + −
15. duck + −	ship + −	*chip*

| 12 | + | | 12 | = | 24 |
| RE Score | | | RE Score | | RE Total Score |

| 11 | + | 10 | = | 21 |
| LE Score | | LE Score | | LE Total Score |

| | | | | = | 45 |
| | | | | | CW--DE Total Score |

Competing Words - Directed Ear

An example of scoring Competing Sentences

Right Ear
Practice Items

a. R The rain came down.
   L She found her purse.
b. R They helped the driver.
   L He climbed the ladder.

Test Items | Words Correct

1. R The park is near the road.	4 /4
L The dog drank from a bowl.	
2. R The dinner plate is hot.	3 /3
L The lady ate a pear.	
3. R The floor looked clean.	2 /3
L The man came early.	
4. R People are going home.	3 /3
L The lady washed the shirt.	
5. R The washing machine broke.	3 /3
L The bath water was warm.	
6. R The ground was very hard.	3 /3
L The kitchen clock was wrong.	
7. R They washed in cold water.	4 /4
L The family bought a house.	
8. R The room is getting cold.	3 /3
L The dog jumped on the chair.	
9. R They broke all the eggs.	4 /4
L The tire had a flat.	
10. R The car is going fast.	4 /4
L The paint dripped on the ground.	

RE Score (sum of words correct) | 33 /35

Left Ear
Practice Items

c. R He caught the ball.
   L The box was full.
d. R They knocked on the window.
   L He dropped his money.

Test Items | Words Correct

11. R The child drank some milk.	4 /4
L They skated on the pond.	
12. R The scissors are sharp.	2 /3
L The oven is hot.	
13. R The baby was pretty.	3 /3
L Some people are coming.	
14. R The fruit came in a box.	3 /3
L They met some new friends.	
15. R She brushed her hair.	3 /3
L They're staying for supper.	
16. R The store closed for lunch.	3 /3
L The football game is over.	
17. R The match fell on the floor.	4 /4
L He wore a yellow shirt.	
18. R The grass is getting long.	3 /3
L The boy slipped on the stairs.	
19. R The children are all eating.	4 /4
L The mother held her baby.	
20. R The police chased the car.	3 /3
L The apple pie was hot.	

LE Score (sum of words correct) | 32 /35

CS Total Score | 65 /70

Interpretation of Test Results:

Results of screening tests are interpreted using criterion referenced scores, so that children are found to either pass or fail the screening battery and do not warrant additional testing, or are considered to be at risk and further testing is recommended.

Results of diagnostic testing are reported as standard scores with the addition of confidence intervals and %ile ranks

The Bell Curve

-2 SD	-1 SD	-0- SD	+1 SD	+2 SD
2%	16%	50%	84%	98%
70 SS	85 SS	100 SS	115 SS	130 SS

Standard Deviations and the Relationship
to
Percentile Ranks
and
Standard Scores
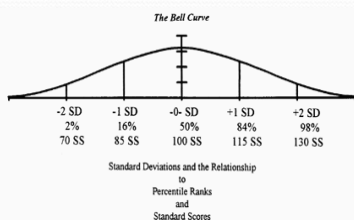
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Interpretation

- The composite standard score is based on
    - Filtered Words
  - Auditory Figure Ground (+8 for children, 0 for adults)
  - Competing Words directed ear
  - Competing Sentences
- The CW free recall and CW directed ear will be analyzed separately for "pure auditory" versus "cognitive" impairment"
- Ear Advantage scores will be analyzed for all tests
- The TCST and other S/N AFG tests not included in the composite standard score is optional, depending on the initial findings and the examiners intent.

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Diagnostic Value of SCAN–3

- Assesses all of the auditory perceptual skills recommended by several position papers
- Normed on a larger sample (i.e., larger *N*) than other available tests for APD
- Well documented standardization procedures
- Reliability and validity data

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Interpretation

- Composite Standard Score
- Individual Test Standard Scores
- Pattern(s) of performance on tests within the battery (overall normal, overall low performance, test scatter)
- Abnormal Ear Advantage(s)
- Comparison of findings on other standardized tests of language and cognition

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Why do we use standard scores when interpreting results?

- Raw scores have no value and cannot be interpreted
- Percent correct have no value – and results cannot be interpreted and compared with other test findings
- Studies reporting cut off scores have little value if not validated on large number of subjects
- Mean and standard deviation has some value but does not allow comparison with other tests
- Development of "local norms" does not allow comparison between facilities/programs/clinics/hospitals

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Composite Standard Scores and Their Corresponding Distances from the Mean and Percentile Ranks

Composite Standard Score	Distance from the Mean	Percentile Rank
145	+3 S.D.	100
130	+2 S.D.	98
115	+1 S.D.	84
100	Mean	50
85	-1 S.D.	16
70	-2 S.D.	2
55	-3 S.D.	0

For composite scores the mean = 100 and SD = 15
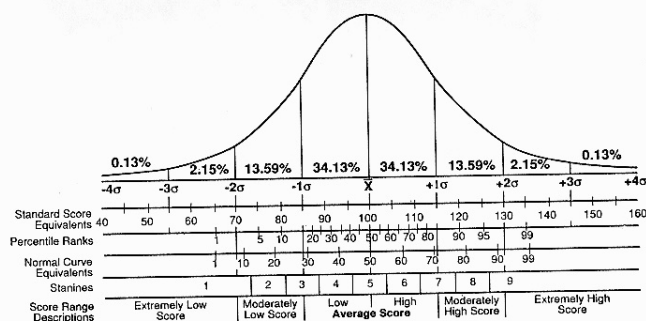
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Subtest Standard Scores and Their Corresponding Distances from the Mean and Percentile Ranks

Subtest Standard Score	Distance from the Mean	Percentile Rank
19	+3 S.D.	100
16	+2 S.D.	98
13	+1 S.D.	84
10	Mean	50
7	-1 S.D.	16
4	-2 S.D.	2
1	-3 S.D.	0

For subtest scores the mean = 10 and one SD = 3

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Relationships among SD, SS, %ile, and score descriptions

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Standard Scores allow the examiner to:

- Compare a subject's score among other standardized tests
- Compare a subject's score to a previous score obtained on the same test
- Compare a subject's performance to a peer of the same age
- Describe the child's performance in comparison to others

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Interpretation – Ear Advantage

You cannot adequately interpret results of APD tests without also considering differences in right versus left ear performance.

Subjects with substantially abnormal ear advantages are more likely to have major problems in auditory processing, language, and reading than typical children.

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CONTINUED™

Summary of Ear Advantage Interpretation in Typical Children

- Monaural Tests of Degraded Speech
  - Ear advantages are not expected at any age

- Dichotic Test Results in Normal Children
  - A right ear advantage exists for all speech materials
  - The right ear advantage is greater as linguistic content increases from CV's to sentences
  - The right ear advantage is maintained on directed right and directed left listening instructions

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Ear Advantages in Children with Auditory Processing Disorders

- Monaural Tests of Degraded Speech may show right or left ear advantages
- Dichotic Test Results
  - Poor overall performance
  - Enhanced REA - directed right (right ear first)
  - Enhanced LEA - directed left (left ear first)
  - LEA under all listening conditions

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What is an adequate method of interpreting AP test results?

- Determine auditory test standard scores including percentile ranks and confidence intervals
- Determine ear differences
- Determine atypical or abnormal auditory processing abilities
- Develop standard score profile for tests of
  - Intelligence
  - Language
  - Auditory Processing
- Determine primary deficit or co-morbidity

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Some issues related to APD testing

- Who is a candidate for testing
  - Age – generally over 6 years
  - Cognitive ability – generally over IQ of 85
  - Linguistic status
    - Native speaker of English
    - Intelligible speech
  - "Normal" hearing
  - Co-morbid diagnoses
    - If on meds for ADHD determine to test "on" or "off"

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A child has abnormal findings on SCAN-3; what next?

- Deficit findings on tests of degraded speech indicate problems of speech understanding in the classroom
  - Those deficits indicate a need for management and compensation in the classroom including assistive listening devices
- Deficit findings on tests of dichotic listening indicate delays of maturation, disorders of the auditory system, or reversed hemispheric dominance for language
  - Those deficits indicate a neurologic basis for listening deficits, language and reading disorders. They may indicate a need for more intense intervention, and a longer habilitation

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A child has abnormal findings on SCAN-3; what next?

- Many of the children with APD will have language or reading disorders.
- Some of the children with APD will have ADD or ADHD and require medication
- Each child will require therapy appropriate to their individual needs that may include
  - Auditory training for subskill deficit, e.g. speech in noise training, verbal working memory training, etc.
  - Traditional language therapy including vocabulary building, language strategies, cognitive strategies, and metacognitive strategies

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Thanks for your interest. Are there any other questions?

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