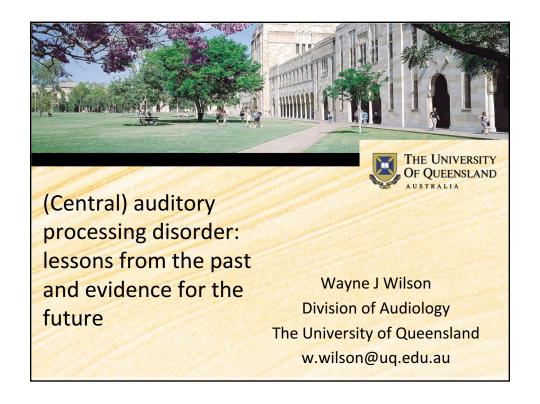
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If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

## continued

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## **OVERVIEW**



#### (C)APD

- 1. Different things to different people
- 2. Lessons from history
- 3. Approaching (C)APD as a clinician: current evidence for
  - a. Screening
  - b. Assessment & diagnosis
  - c. Re/habilitation
- 4. The decision is your to make as a well informed clinician and researcher



## What is (C)APD?



## Isn't (C)APD simply DPA(C)?

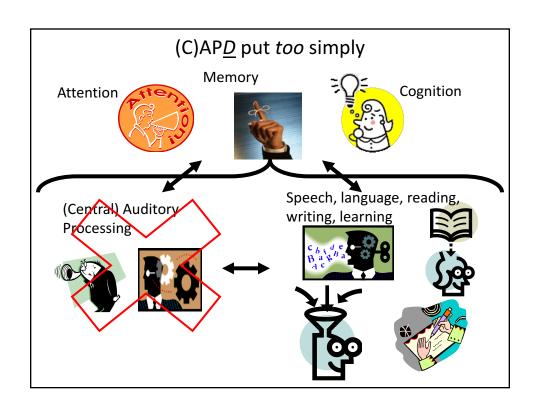
That is, isn't (C)APD:

a <u>disorder</u> (not just a difficulty)

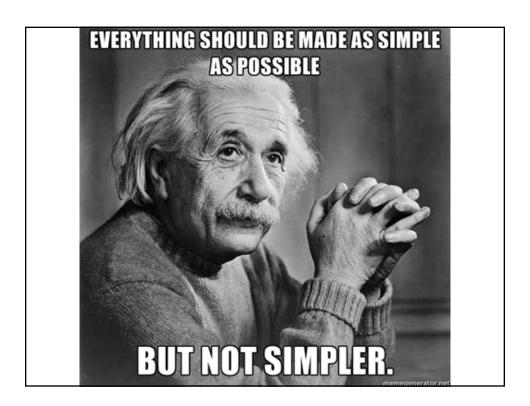
of *processing* (not necessarily perception)

of <u>auditory</u> information (not visual, kinaesthetic, etc; not language)

in the *central* nervous system (particularly the CANS)?









1. "APD means different things to different people" (Jerger, 2009, p. 10)





## 2. Lessons from history

## History – 6 approaches (Jerger, 2009, & beyond)



- Early pioneers (late 1800s & early 1900s)
  - Link between brain injury and disturbances of receptive & expressive language (Broca, Wernicke, Jackson, Head, Freud, etc)

#### 6 Approaches

- I. The *audiological* approach
- II. The *psychoeducational* approach
- III. An approach based on the possible impact APD could have on language acquisition and learning
- IV. An approach based on the requirement that (C)APD be *modality specific*
- V. An approach based on the defining feature of (C)APD being a *deficit in auditory attention*
- VI. An approach based on "listening difficulties"



## I. The *audiological* approach



 Based on the concept that a person with brain injury exhibits certain behaviours; ergo, if tests reveal these same behaviours, then a link to brain injury is established

## History



Time	Audiological Approach
1950s	Disturbed auditory perception in children with normal audiograms (Mykleburst, 1954)  "Sensitized" word lists detect temporal lobe lesions in adults (Bocca et al., 1954-55)  Dichotic digits (Broadbent, 1958)
1960s	SSW (Katz, 1962) Dichotic CVs (Berlin et al., 1968)
1970s	DST (Willeford, 1977)  SSI-ICM & SSI-CCM (Jerger et al., 1974, 1975)  TC &/or RS (Beasley et al., 1977; Kurdziel et al., 1976)  LPFS (Lynn et al., 1977)
1980s	DSI (Fifer, Jerger et al., 1983)  FPT & DPT (Pinheiro & Musiek, 1985)  LPFS (Keith, 1986)
2000s	Gap detection (Keith, 2000; Musiek et al., 2005)



## Evidence for *audiological* approach



- E.g., SSW in adults:
  - Temporal lobectomy (Berlin, Chase, Dill & Hagepanos, 1965)
  - Tumour (Jerger & Jerger, 1975; Lynn & Gilroy, 1975)
  - Stroke (Katz & Pack, 1975)
  - Commissurotomy (Baran, Musiek & Reeves, 1986; Musiek & Wilson, 1979)
  - Degenerative disorders such as Alzheimer's disease (Grimes, Grady, Foster, Sunderland & Patronas, 1985)
- E.g., Musiek et al. (2011). CAP test batteries & brain lesions in adults



Table 8. Sensitivity, Specificity, and Efficiency Values for Specific Combinations of CAP Tests Using the Strict Criterion in Which a Positive Diagnosis Is Made on the Basis of Failure on All Tests in the Battery



		Two tests	
DD/FP	16/20 = 80%	27/29 = 93%	43/49 = 88%
DD/FS	10/20 = 50%	27/29 = 93%	37/49 = 76%
DD/CS	14/20 = 70%	29/29 = 100%	43/49 = 88%
FP/FS	10/20 = 50%	29/29 = 100%	39/49 = 80%
FP/CS	14/20 = 70%	29/29 = 100%	43/49 = 88%
FS/CS	8/20 = 40%	29/29 = 100%	37/49 = 76%
		Three tests	
DD/FP/FS	10/20 = 50%	29/29 = 100%	39/49 = 80%
DD/FP/CS	13/20 = 65%	29/29 = 100%	42/49 = 86%
DD/FS/CS	8/20 = 40%	29/29 = 100%	37/49 = 76%
FP/FS/CS	8/20 = 40%	29/29 = 100%	37/49 = 76%
		Four tests	
DD/FP/FS/CS	8/20 = 40%	29/29 = 100%	37/49 = 76%

Figure 1. Cortical site of lettion location compiled access all yar talgams in the experimental group. Approximate extent of the con-

## Evidence for *audiological* approach



- Fewer studies with confirmed lesions in *children* 
  - Drake (1968)
  - Galaburda and Kemper (1979)
  - Musiek et al. (1985)
  - Musiek and Gollegly (1988)
  - Boscariol et al. (2009, 2010, 2010)



## II. The *psychoeducational* approach of Queensland approach of Queensland



- Based on the concept of a set of primary (discrete) auditory abilities that can be tested by appropriate techniques
- Target children for (C)AP evaluation because of assumed *learning problems*

## History



Time	Psychoeducational approach					
1940s	Construct: disturbances in perception, thinking & emotion caused by brain injury in children can be demonstrated by testing (Strauss & Lehtinen, 1947)  Gf-Gc theory of cognitive abilities (Cattell, 1941)					
1960s	Illinois Test of Psycholinguistic Abilities (Kirk, 1968). Perceptual-motor domain contained 5 categories: aud. reception, aud. association, aud. sequential memory, aud. closure & sound blending  Gf-Gc theory of cognitive abilities (Horn, 1965)					
1970s	Goldman-Fristoe-Woodcock Scale (1974). 4 dimensions of AP: aud. discrimination, aud. memory, aud. selective attention & sound-symbol association					
1990s	Three Stratum Theory of Cognitive Abilities (Carroll, 1993)  Cattell-Horn & Carroll (CHC) Theory of Intelligence & Assessment  CHC theory expanded (McGrew, 1997; Flanagan & McGrew, 1998)  Aud. processing skills listed by ASHA (1996)					
2000s	Woodcock-Johnston III Tests of Cognitive Abilities (Woodcock et al., 2001) CHC theory expanded (McGrew, 2005, 2011)					



#### CHC Theory of Intelligence & Assessment



- Many theoretical constructs have been developed, e.g., Cattell-Horn & Carroll (CHC) Theory of Intelligence & Assessment
- 9 broad stratum abilities (and over 70 narrow abilities):
  - Crystallized Intelligence (Gc)
  - Fluid Intelligence (Gf)
  - Quantitative Reasoning (Gq)
  - Reading & Writing Ability (Grw)
  - Short-Term Memory (Gsm)
  - Long-Term Storage and Retrieval (GIr)
  - Visual Processing (Gv)
  - Auditory Processing (Ga): is the ability to analyze, synthesize, and discriminate auditory stimuli, including the ability to process and discriminate speech sounds that may be presented under distorted conditions
  - Processing Speed (Gs)

- III. An approach based on the possible impact APD could have on language acquisition and learning of Queensland
  - It is not unreasonable to suppose that problems in auditory perceptual processing could lead to problems in language acquisition and to subsequent learning disability



## History



Time	Approach based on language & learning
1970s	Construct: If audition → language, & language → learning, then poor audition → poor language and learning "Rapid Auditory Processing" (Tallal et al., 1973)  Rees (1973) (argued against [C]APD)
1980s	"Rapid Auditory Processing" (Tallal et al., 1980) Sloan (1980, 1986)
1990s	Sloan (1992)  "Rapid auditory processing" (Tallal et al., 1996)  Attempts to link other (C)APs to language (e.g., Bishop et al., 1999)  "Auditory Perceptual Deficit Models"
2000s	Attempts to link other (C)APs to language (e.g., Dawes et al., 2009) "Auditory Perceptual Deficit Models"

## Evidence for approach *based on language acquisition*



- Summary
  - Not all children with language learning impairments demonstrate non-verbal auditory processing problems, and vice versa (summarized in McArthur & Bishop, 2004)
  - (C)APD may be a 'synergistic risk factor' for language impairment that exerts a moderating influence when children are already at genetic risk of language disorder, but (C)APD is neither necessary nor sufficient to explain language difficulties (Bishop et al., 1999)



#### IV. An approach based on *modality specificity*



- Consider three groups of individuals, all of whom perform poorly on tests of (C)AP:
  - Specific perceptual problems processing information presented auditorily ([C]APD in its "purist" form)
  - Auditory perceptual problems that coexist with other processing problems
  - No auditory processing problems per se, but other problems with motivation, attention, memory, motor skills etc
- "Thus the differential diagnosis of sensory-specific perceptual deficits can be considered a form of hypothesis testing where the goal is to determine in which of the three groups described above a given individual belongs"

(McFarland and Cacace, 1995, p. 37)

## History



Time	Approach based on modality specificity
1990s	McFarland & Cacace (1992, 1995a,b, 1997) <b>Cacace &amp; McFarland (1998)</b> McFarland, Cacace & Setzen (1998)
2000s	Cacace, McFarland, Ouimet, Schrieber & Marro (2000)  Cacace & McFarland (2005, 2006)  Bellis, Billet & Ross (2008)  Bellis & Ross (2011)  Cacace & McFarland (2012, 2013)  McFarland & Cacace (2009, 2012)



### Evidence for approach based on modality specificity



- Defines (C)APD as a "modality specific perceptual dysfunction that is not due to peripheral hearing loss" (McFarland and Cacace, 1995b; Cacace and McFarland, 2005, 2013)
- Notes that perception in general, and auditory perception in particular, is not a behaviour: it is a "theoretical construct".
- Emphasizes the roles of convergent and divergent validity in realizing the concept of (C)AP
- Bellis, Billiet & Ross (2008) and Bellis & Ross (2011) have shown different performances on equivalent diotic and dichoptic tasks in healthy adults and children and children with (C)APD

V. An approach based on the defining feature of (C)APD being a *deficit in auditory* attention



- (C)APD should be defined by:
  - the features of children referred for a (C)AP assessment that ...
  - most correlate with the listening problems reported by the child's teachers, parents, etc, ...
  - with *auditory attention* appearing to be the key feature



### History



Time	Approach based on auditory attention					
	Attempts to define (C)APD based on the characteristics of children referred for a					
Late	(C)AP assessment and how closely these characteristics relate to the listening					
2000s	problems reported by the child's teachers, parents, etc. (mostly Moore et al.,					
	2010)					

### Evidence for approach based on auditory attention



- Nature of APD in children (Moore et al., 2010)
- Found children's classroom performance (CCC-2 &/or CHAPS) was best predicted by:
  - ★ intensity, frequency & temporal discrimination (AP)
  - ★ derived intensity, frequency & temporal discrimination ("pure AP")
  - **x** speech-in-noise
  - x visual attention
  - ✓ cognition (IQ, memory, language, and literacy)
  - ✓ auditory attention
- Suggested APD is *primarily an (auditory) attention problem* and that clinical diagnosis and management, as well as further research, should be based on that premise



### VI. An approach based on "listening difficulties" 💹



- "... deliberately not attempting to define APD"
- Instead, "focus on the diagnosis and management of listening difficulties

(Dillon et al., 2012, p. 98)

## Evidence for approach based on "listening difficulties"



 "Despite several consensus and position statements, disagreement abounds over what constitutes an APD. These issues may well be just *matters of arbitrary* definition, incapable of resolution by any scientific experiment, though in the fullness of time, some definitions will likely be found to be more helpful than others"

(Dillon et al., 2012, p. 98)



#### THE UNIVERSITY History - summary OF QUEENSLAND Approach Approach Approach Approach Psychobased on Audiological based on based on based on Time educational listening (not Approach language & modality auditory defining approach learning specificity attention [C]APD) perception Gf-Gc theory 1940s Disturbed aud. perception 1950s Sensitized words Dichotic digits 1960s SSW, DCVs Gf-Gc theory Construct: (C)AP → lang. & learn. DST, SSI-ICM, SSI-1970s **GFW Scale** CCM, TC RS, LPFS DSI, FPT, DPT, 1980s RAP 3 Stratum Theory Cacace & CHC theory 1990s Auditory McFarland ASHA (1996) **Perceptual Deficit** Auditory CHC theory Cacace & 2000s GD, LISN-S Moore et al. Dillon et al. W-J III TCA Perceptual Deficit McFarland

## The "big 3"



- 1. American Speech-language, Hearing Association (ASHA, 2005)
- 2. American Academy of Audiology (AAA, 2010)
- 3. British Society of Audiology (BSA, 2011a,b; Moore et al., 2012)



#### Also ...



- 4. Canadian guidelines on auditory processing disorder in children and adults: Assessment and intervention (CISG, 2012)
- 5. German consensus statement on (C)APD (Nickish et al., 2007)
- 6. New Zealand Government Tender. Review and Position Paper on Auditory Processing Disorder. In preparation.
- 7. Audiological Society of Australia Central Auditory Processing Special Interest Group. In progress.

#### ASHA (2005)/AAA (2010) vs BSA (2011)



(Wilson & Arnott, 2012, table 12-1, p. 285)

#### ASHA (2005)

#### Definition

APD refers to difficulties in the perceptual processing of auditory information in the central nervous system, as demonstrated by poor performance in one or more of the following skills:

- · sound localization and lateralization
- · auditory discrimination
- auditory pattern recognition
- · temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection)
- temporal ordering and temporal masking
- · auditory performance in competing acoustic signals (including dichotic listening), and
- · auditory performance with degraded acoustic signals.

#### BSA (2011a)

#### Definition

APD is characterized by poor perception of both speech and nonspeech sounds.

APD has its origins in impaired neural function.

APD impacts on everyday life primarily through a reduced ability to listen, and so respond appropriately to sounds.

APD does not result from a failure to understand simple instructions.

APD is a collection of symptoms (although the specific symptoms are not explicitly stated) that usually co-occurs with other neurodevelopmental disorders.



#### ASHA (2005)/AAA (2010) vs BSA (2011)



(Wilson & Arnott, 2012, table 12-1, p. 285)

#### ASHA (2005)

#### BSA (2011a)

Although APD may coexist with, lead to, or be associated with disorders of higher order language, cognition or related factors, it is not the result of such disorders.

Cognitive factors such as attention, rather than being a potential confound, may make a significant contribution to APD.

- · Individuals suspected of having (C)APD frequently present with one or more behavioral characteristics
- List of behaviours is illustrative, not exhaustive & not exclusive to (C)APD
- Behaviors not specifically diagnostic of (C)APD
- · No consensus on presenting symptoms/behaviours of (C)APD
- · We should focus on core symptom or symptoms that reflect and contribute to clinical presentation
- · Carefully constructed parent/caregiver evaluations might lead to a gold standard



# 3. APPROACHING (C)APD AS A **CLINICIAN**



## Approaching (C)APD



- Many approaches (e.g. AAA, 2010; ASHA, 1996, 2005; Bellis & Ferre, 1999; Bellis, 2003; BSA, 2007, 2011; Domitz & Schow, 2000; Jerger & Musiek, 2000; Katz, Stecker, & Henderson, 1992; Musiek & Chermak, 1994; Musiek, Geurkink, & Kietel, 1982; Neijenhuis, Stollman, Snik, & van der Broek, 2001; Willeford, 1977)
- Recently dominated by the recommendations of ASHA (2005) & AAA (2010)
- BSA's (2011a,b) similar to ASHA (2005) & AAA (2010), with some key differences that reflect different theoretical constructs



# 3. APPROACHING (C)APD AS A **CLINICIAN** a. Screening



## Screening for (C)APD



- Ability to separate children with/out CAPD (mostly "ASHA-like") (Wilson, 2014)
- **Questionnaires & Checklists** 
  - CHAPS: 4 yes, 5 no (Dawes et al., 2008, 2010; Ferguson et al., 2011; Iliadou et al., 2012; Moore et al., 2010; Drake et al., 2006; Lam et al., 2007; Sharma, et al., 2009; Wilson et al., 2011)
  - FAPC: 1 no (Dawes et al., 2008)
  - O LIFE: 1 yes (2 items only) (Johnston et al, 2009)
  - SIFTER: 1 yes (academics subscore only), 1 no (Johnston et al., 2009; Wilson et al., 2011)
- Tests
  - HINT: 1 yes, 1 no in adults (Fuente et al., 2006, 2011); 1 yes (HINT-quiet score only) in children (Johnston et al., 2009)
  - o PSI: 2 yes (Jerger, 1987; Jerger et al., 1988)
  - TEA-Ch: 1 no (Lam et al., 2007)
  - UQUEST: 1 yes (Wilson et al., in press)
- Test batteries
  - MAPA: 1 yes (Domitz & Schow, 2000)
  - SCAN: 1 no (Domitz & Schow, 2000)
  - O SCAN-C: 1 no (Madison, Hallberg, Anfinson, DeMaio, & Drake, 2005)
  - SCAN-A: 1 yes (competing sentences subtest only) (Lam & Sanchez, 2007)
  - TAPS-R: 1 no (Wilson et al., 2011)

## Screening for (C)APD



#### Verdict

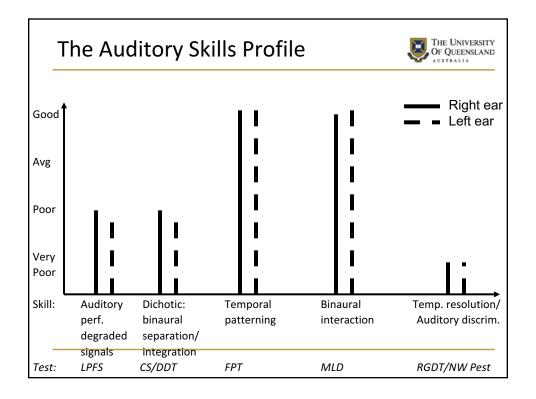
• Evidence for screening is equivocal with no single tool standing out as a best candidate for screening for (C)APD



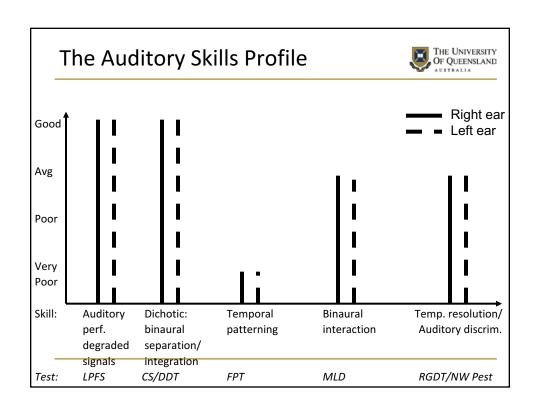


# 3. APPROACHING (C)APD AS A **CLINICIAN**

b. Assessment







		history				AUSTRALIA		
Time	Audiological Approach	Psycho- educational approach	Approach based on language & learning	Approach based on modality specificity	Approach based on auditory attention	Approach based on listening (no defining [C]APD)		
1940s		Construct: testing perception  Gf-Gc theory						
1950s	Disturbed aud. perception Sensitized words Dichotic digits							
1960s	SSW, DCVs	ITPA <b>Gf-Gc theory</b>						
1970s	DST, SSI-ICM, SSI- CCM, TC RS, LPFS	GFW Scale	Construct: (C)AP  → lang. & learn.  RAP					
1980s	DSI, FPT, DPT, LPFS		RAP					
1990s		3 Stratum Theory CHC theory ASHA (1996)	RAP Auditory Perceptual Deficit	Cacace & McFarland				
2000s	GD, LISN-S	CHC theory W-J III TCA	Auditory Perceptual Deficit	Cacace & McFarland	Moore et al.	Dillon et al.		



# 6. APPROACHING (C)APD AS A **CLINICIAN** c. Diagnosis

## Diagnosing (C)APD – the "big 3" + others



- ASHA (2005): fail  $\geq 2$  tests by  $\geq 2$  SD, or fail ≥ 1 test by ≥3 SD, plus no inconsistencies among tests
- AAA (2010): fail in  $\geq 1$  ear on  $\geq 2$  tests by  $\geq 2$  SD, & no inconsistencies among tests
- BSA (2011): fail ≥2 tests, ≥1 involving speech sounds & ≥1 involving non-speech sounds
- Dawes et al. (2009) fail ≥1 test involving non-speech sounds McArthur (2009)
- Bellis (2003) fail in pattern consistent with subprofile Katz (1992)



## **Evidence - history**



Time	Audiological Approach	Psycho- educational approach	Approach based on language & learning	Approach based on modality specificity	Approach based on auditory attention	Approach based on listening (not defining [C]APD)
1940s		Construct: testing perception  Gf-Gc theory				
1950s	Disturbed aud. perception Sensitized words Dichotic digits					
1960s	SSW, DCVs	ITPA <b>Gf-Gc theory</b>				
1970s	DST, SSI-ICM, SSI- CCM, TC RS, LPFS	GFW Scale	Construct: (C)AP  → lang. & learn.  RAP			
1980s	DSI, FPT, DPT, LPFS		RAP			
1990s		3 Stratum Theory CHC theory ASHA (1996)	RAP Auditory Perceptual Deficit	Cacace & McFarland		
2000s	GD, LISN-S	CHC theory W-J III TCA	Auditory Perceptual Deficit	Cacace & McFarland	Moore et al.	Dillon et al.

## Criticism of various diagnostic criteria



- Wilson & Arnott (2012)
  - 9 diagnostic criteria (based on ASHA, AAA, BSA & others) applied to 150 children who had completed the same (C)APD test battery
  - Diagnosis rates ranged from 7.3% to 96%
  - Any diagnosis of (C)APD should be qualified by an explicit statement of the criteria used
- Dillon et al. (2012)
  - Current diagnostic criteria are arbitrary
  - How poor must the test scores be on how many tests before the person will actually have a problem in real life?
- Cacace & McFarland (1995, 2013)
  - (C)APD is a construct, not a behaviour
  - Assessment should be a form of hypothesis testing to delineate modality specific perceptual dysfunctions from supramodal or polysensory dysfunctions





# 6. APPROACHING (C)APD AS A **CLINICIAN** b. Re/habilitation

### Reviewed by:



• Wilson, W. J., & Arnott, W. (2012a). Evidence about the effectiveness of interventions for auditory processing disorder. In L. Wong & L. Hickson (Eds.), Evidence-based practice in audiology: Evaluating interventions for children and adults with hearing impairment (pp. 283-308): Plural Publishing.



## Environmental modifications - FM systems THE UNIVERSITY OF QUEENSLAND



- Personal FM systems
  - Lemos (2009)
    - 20 studies, 3 level III & the rest level IV; results +ve but no control groups
  - Johnson et al. (2009)
    - Level III; improved performance on AP, academic & psychosocial
    - But language confounds in AP measure & control group only in pre-treatment phase
  - Hanschmann et al. (2010)
    - Level III; improved sentence in noise performance for both children with APD & controls
    - · Again, language confounds

Verdict: some evidence emerging but higher level evidence needed ([C]APD was mostly "ASHA-like")

## Compensatory strategies



- CSs seek to improve the listener's ability to take control of his or her own situation, i.e. to actively try to compensate for his or her own difficulties
- As per EMs, while CSs have prima facie value, it should not be assumed that other improvements will immediately follow

Verdict: no studies directly investigating the effects (if any) of CSs on (C)APD



## Direct intervention - auditory outcomes University Of Queensland



- Fey et al. (2011): 6 studies, level IIb & most level III
- McArthur (2009): 6 studies, Levels Ib-III
- Loo et al. (2010): 21 studies, levels Ib-III
- More recently
  - Cameron & Dillon (2011): LiSN & Learn
  - Sharma et al. (2012): env. mods + comp. strat. + direct int.

## Direct intervention - auditory outcomes Of QUEENSLAND



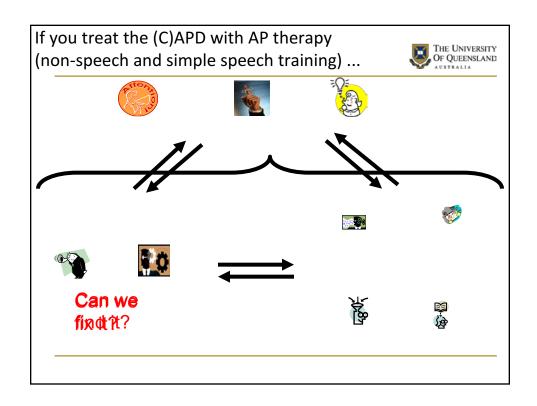
Verdict: The evidence that direct auditory interventions improve AP in school-age children with APD with or without spoken language, reading, or learning difficulties, compared to no treatment or placebo treatments, is:

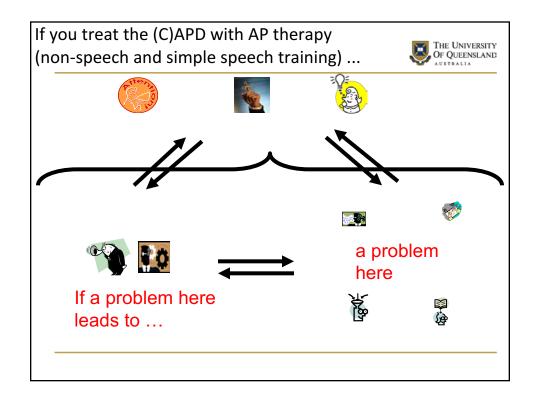
- suggestive-to-compelling for interventions involving nonspeech and/or simple speech stimuli (noncomputer or computer-based),
- suggestive for Earobics, and
- equivocal for Fast ForWord.

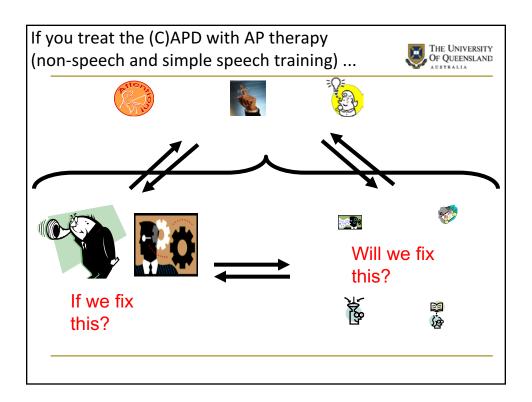
The evidence that AIT has no effect on AP is suggestive.

(In the short-term, in school aged children, where [C]APD was mostly "ASHA-like")









## Language Outcomes



- Fey et al. (2011): 19 studies, level IIb & most level III
- McArthur (2009): 6 studies, Levels Ib-III
- Loo et al. (2010): 21 studies, levels Ib-III
- More recently
  - Sharma et al. (2012): env. mods + comp. strat. + direct int.



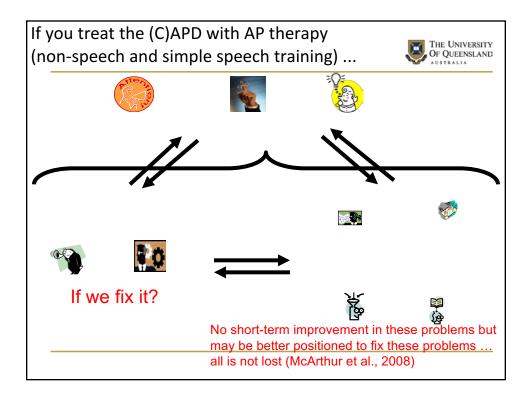
## Language Outcomes



Verdict: The evidence is suggestive to compelling that direct auditory interventions including computer-based interventions involving nonspeech and/or simple speech training and Fast ForWord do not improve spoken language and/or reading skills in school-age children with spoken language and/or reading disorders with or without APD, compared to no treatment or placebo treatments.

The evidence is suggestive that Earobics improves phonological awareness skills in this patient population.

(In the short-term, in school aged children, where [C]APD was mostly "ASHA-like")





#### **OVERVIEW**



#### (C)APD

- 1. Different things to different people
- 2. Lessons from history
- 3. Managing (C)APD: current evidence for
  - Screening for (C)APD
  - b. Assessing for and diagnosing (C)APD
  - Re/habilitating (C)APD
- 4. The decision is your to make as a well informed clinician and researcher









AAA. (2010), American Academy of Audiology clinical practice guidelines; Diagnosis, treatment and management of children and adults with central auditory processing disorder. from www.audiology.org/resources/documentlibrary/Documents/CAPD%20Guidelines%208-2010.pdf AHSA. (2005). (Central) auditory processing disorders. Available at http://www.asha.org/policy/TR2005-00043.htm.

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