Thinking about the causes of developmental disorders of cognition

Max Coltheart

Scientific Director, Macquarie Centre for Cognitive Science

Academic Director, Children's Hospital Education Research Institute

Some developmental disorders of cognition

- developmental dyslexia
- developmental dysgraphia
- specific language impairment
- developmental prosopagnosia

These are children poor for age at one of:

- reading
- spelling
- spoken language
- face recognition

What might we mean by a **“cause”** of a child’s reading problem?

Why does MI read like this?

island	→	“iz-land”	*break*	→	“breek”
quay	→	“kway”	*yacht*	→	“yatched”
shoe	→	“show”			

Is it because his visual word recognition system is abnormal (too few words in it)?

Or is it because of a genetic abnormality on Chromosome 15?

Why was JF so bad at reading simple nonwords?

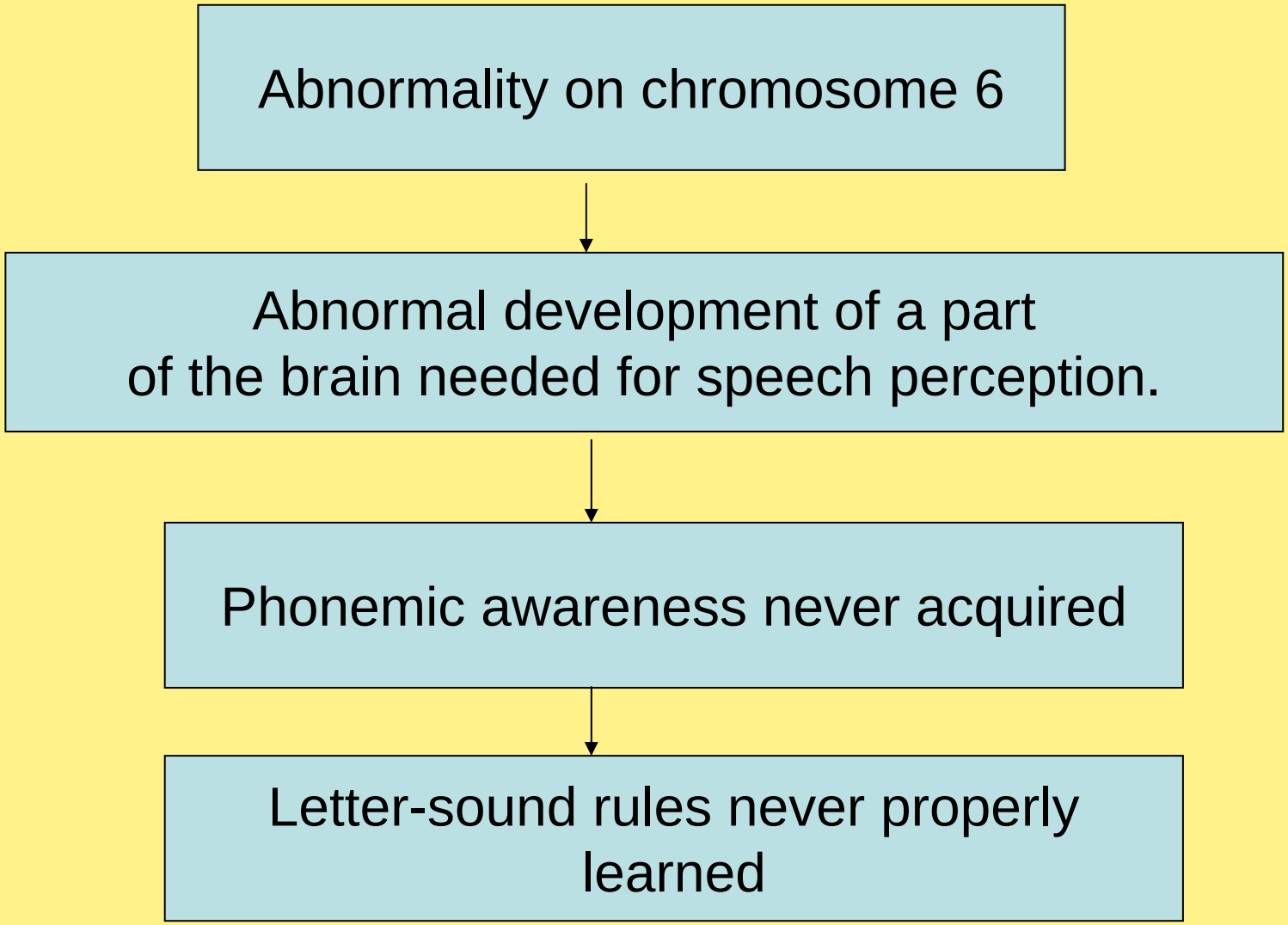
Was it because her knowledge of letter-to-sound correspondences was so poor?

Or was it because her phonemic awareness was so poor?

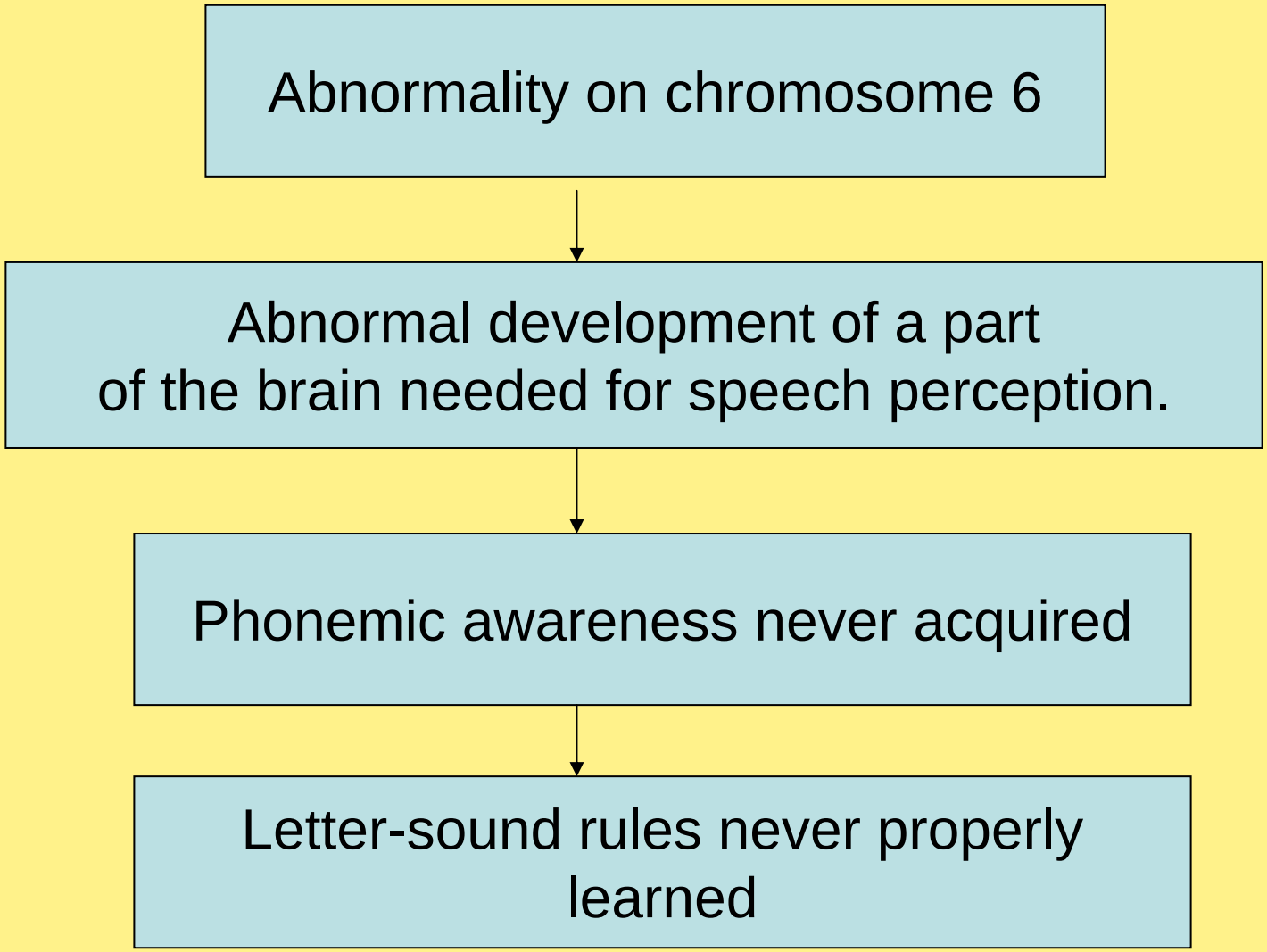
Or was it because of a genetic abnormality on chromosome 6?

The ORs are wrong here, because the answer ***could*** be: "All of the above"

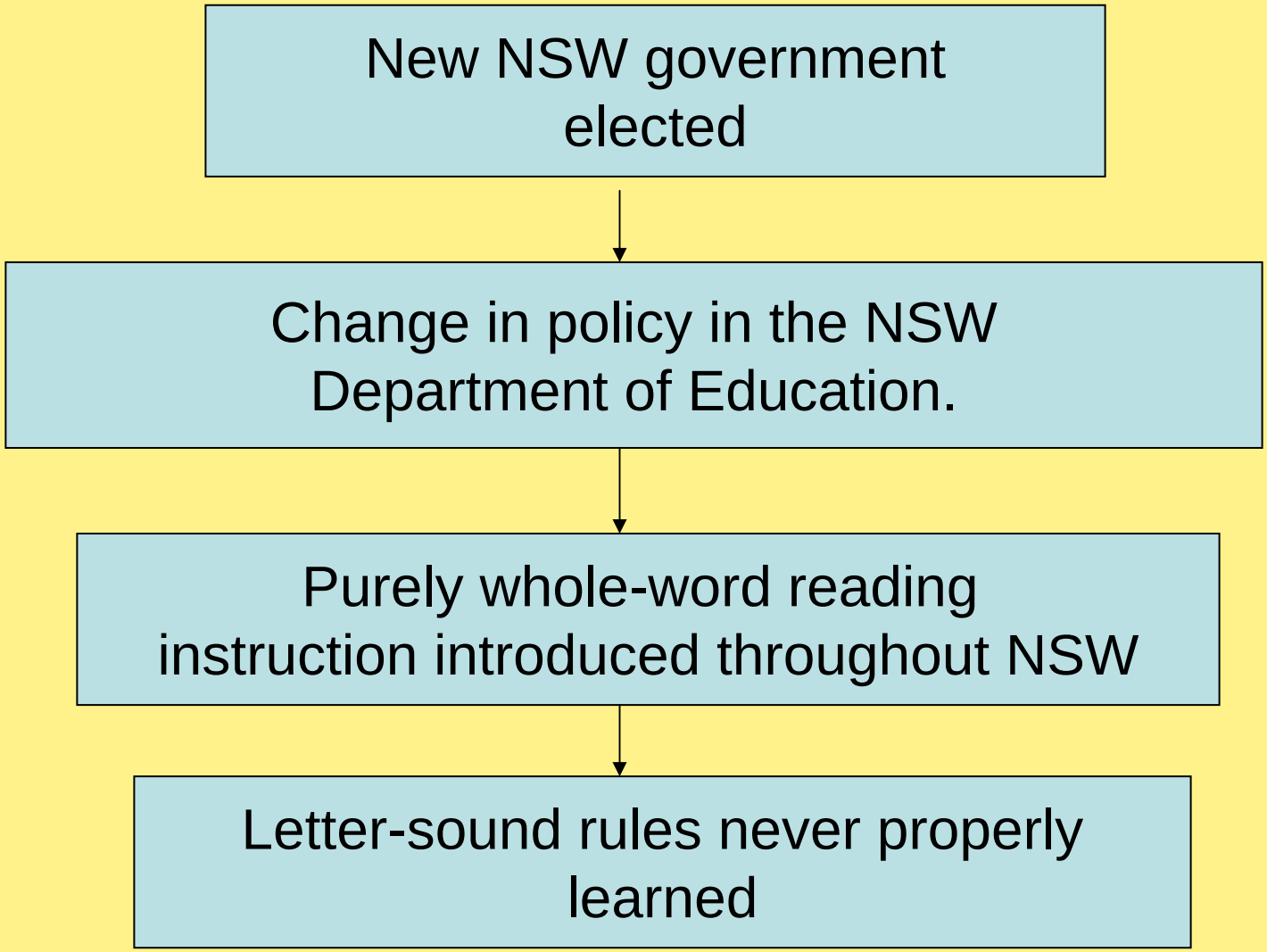
Why was JF so bad at reading simple nonwords?
One possible explanation:



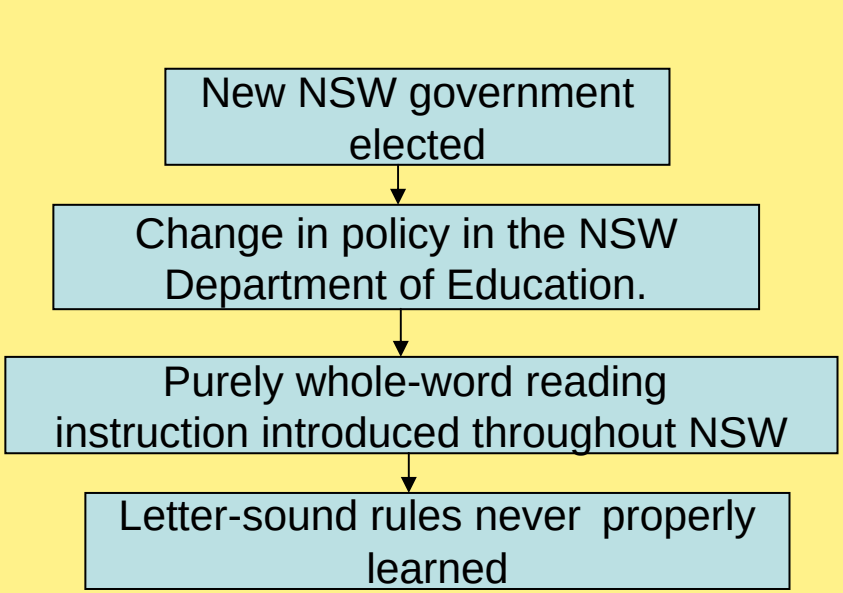
Why was JF so bad at reading simple nonwords?
No single cause: instead, a causal chain.



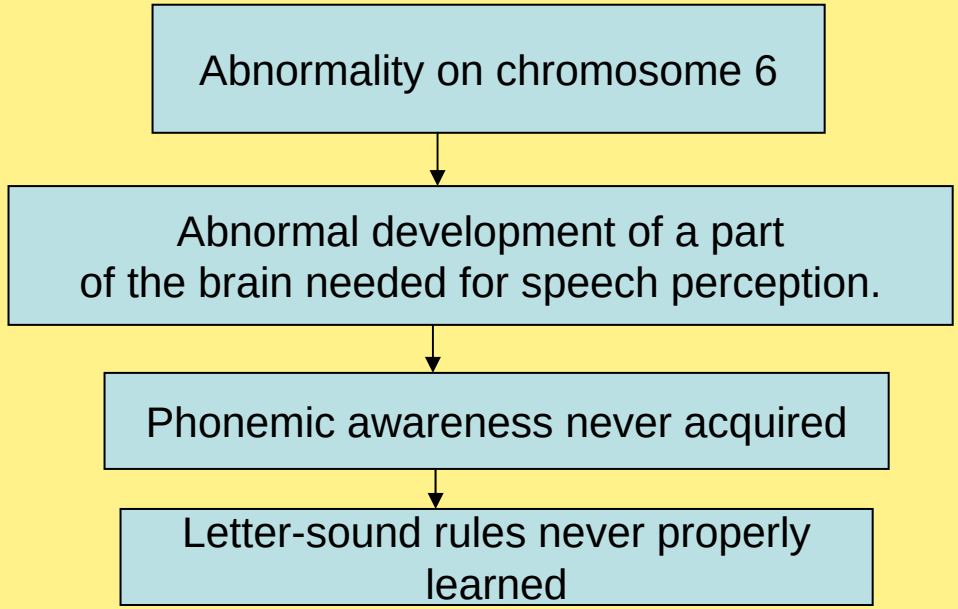
Why was JF so bad at reading simple nonwords?
Another possible explanation:



Why was JF so bad at reading simple nonwords? Two possible causal chains



CHILD A



CHILD B

Two of many possible causal routes to the ***same reading symptom***, poor nonword reading.

There could be two children with exactly the same reading symptom but two different causal routes.

Proximal and distal causes of reading difficulties

If a child's Reading System is normal for his or her age, then that child's reading will also be normal for age.

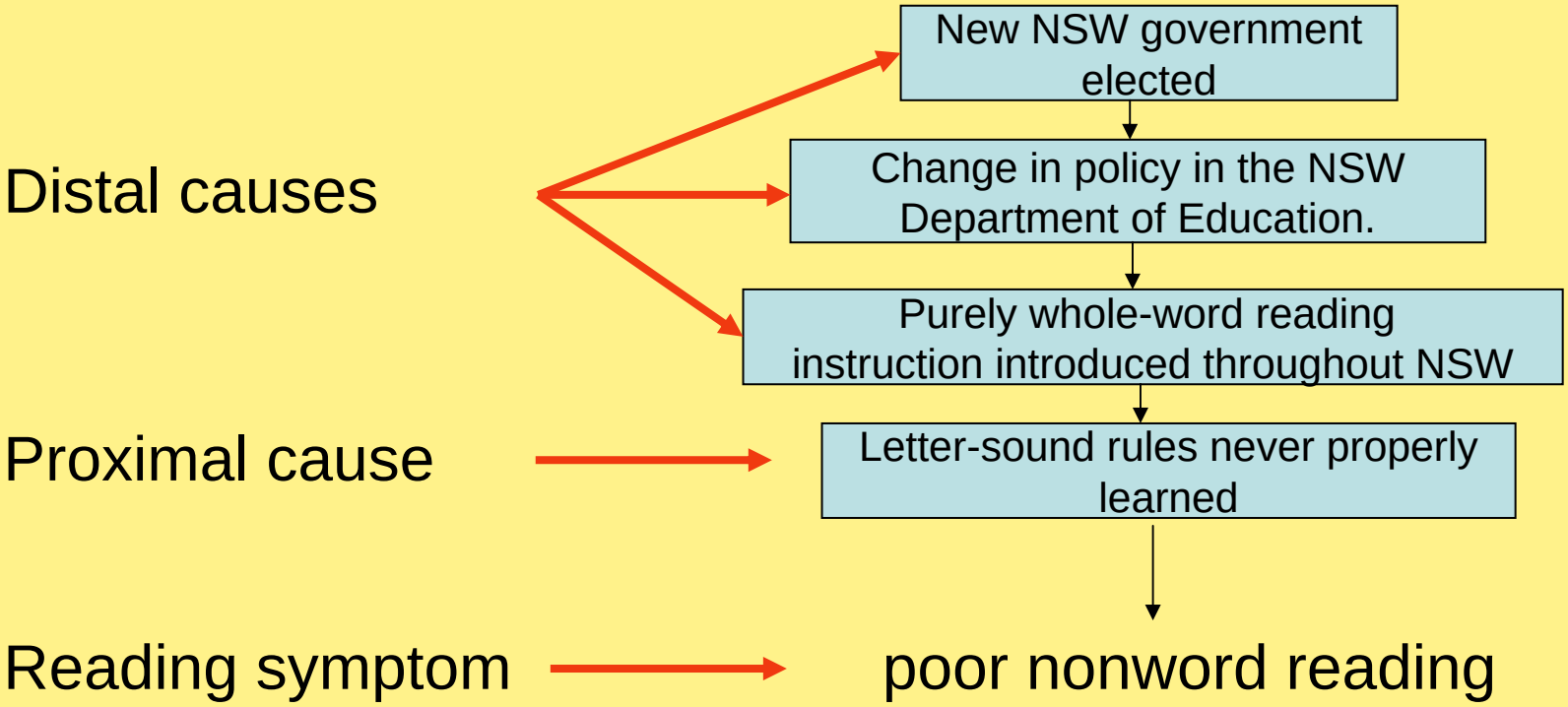
So whenever a child's reading is abnormal for age, that child's Reading System must also be abnormal in some way

It is that abnormality of the Reading System that is the direct cause of the abnormal reading behaviour

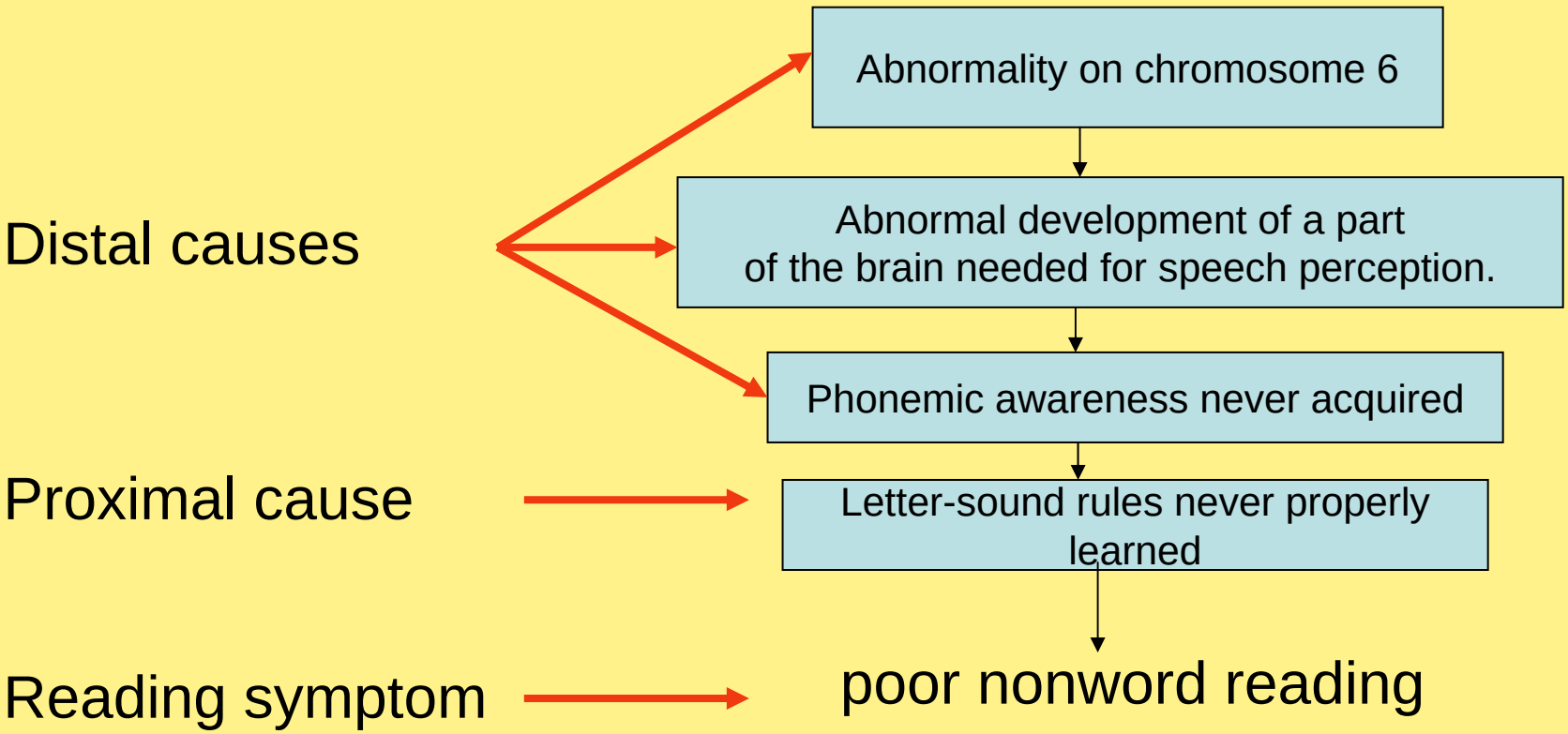
So the last link in the causal chain is ***always*** some abnormality of the Reading System

This is the ***proximal cause*** of the abnormal reading

Proximal and distal causes of reading difficulties



Proximal and distal causes of reading difficulties



Proximal and distal causes of reading difficulties

There's always a proximal cause, and it is always an abnormality of the Reading System - that is, the proximal cause is always at the ***cognitive*** level

There's always at least one distal cause – often a chain of distal causes leading up to the proximal cause.

A distal cause can be at the ***environmental*** level:

- Lead in the atmosphere
- A change of Government

Or the ***biological*** level:

- Genetic abnormality
- Brain damage at birth

Or the ***cognitive*** level:

- Poor phonemic awareness

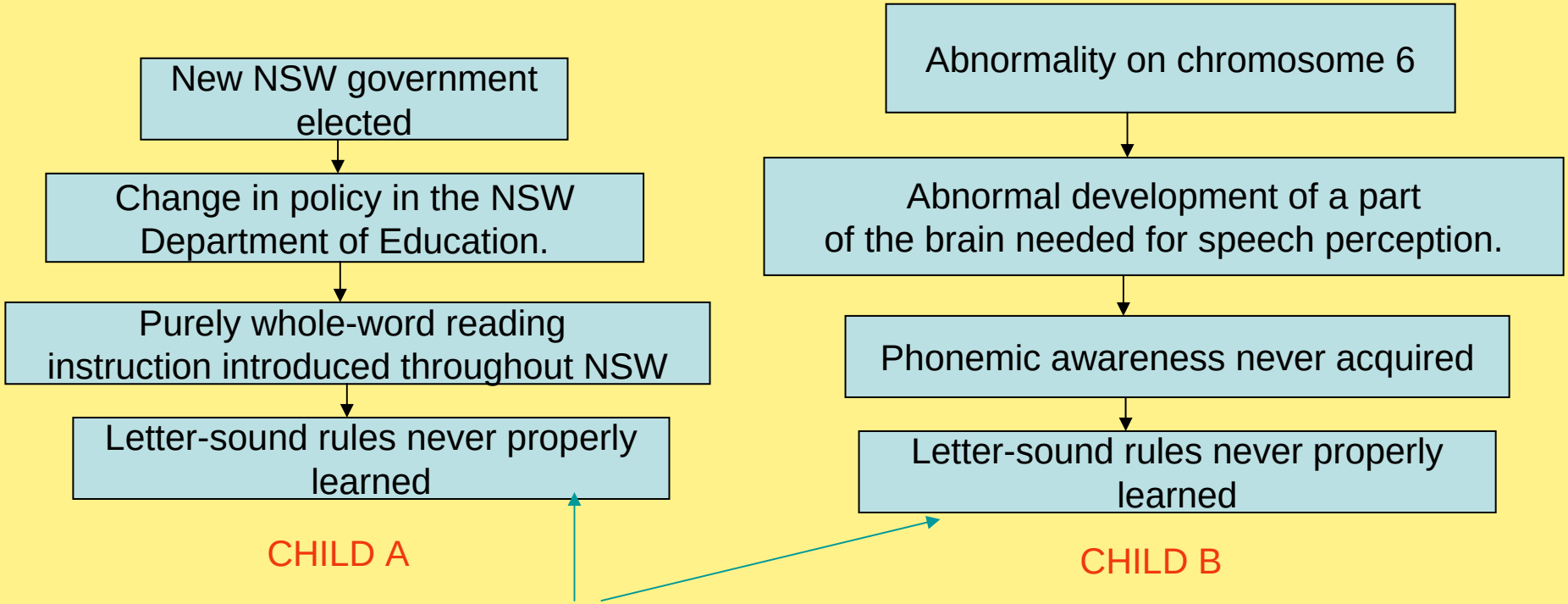
Proximal and distal causes of reading difficulties

Proximal cause question: What's abnormal about this child's reading system?

Distal cause question: What's the reason for the abnormality of the child's Reading System?

Both questions need to be answered if we are to fully understand any case of reading difficulty.

Proximal and distal causes of reading difficulties: implications for intervention



Same proximal cause in both children

Different distal causes: environmental in Child A, biological in child B

This does not imply that an intervention that works for one child would not work for the other

Treatment and the proximal/distal distinction

Performance will only become normal if the proximal cause is removed I.e. the relevant cognitive system becomes normal for age.

Suggests that treatment should be directed at the proximal cause, not at distal causes. Correction of a distal cause might render the child more able to acquire the relevant cognitive skill, but that acquisition still has to happen

Critical periods may be of relevance here.

If treatment is to be focussed on the proximal cause, then in two children with the same proximal cause but different distal causes is it necessary to consider distal cause when deciding upon treatment method? My guess is not.

Distal causes can be cognitive

- *Example 1:* Poor phonemic awareness causes difficulty in learning to read.
- *Example 2:* Acquired deafness leads to abnormalities in the quality of speech.
- In both cases, the cause is cognitive, but nevertheless it is not proximal - it is ***distal.***
- That's because we don't use phonemic awareness as we read on-line: phonemic awareness ability is not part of the Reading System. It's used for learning to read, not for on-line reading.
- And monitoring the nature of our speech is not a component of the speech production system. It is used for learning about our speech output (throughout life), not during on-line speaking.

The RightNow! criterion

Unsure about whether a certain cause ought to be thought of as distal or proximal?

Then apply the RightNow! criterion

The RightNow! criterion

Suppose a child is developmentally dyslexic. Which of the following actions could make an ***immediate*** difference to the child's reading performance?

- Repair chromosome 6
- Change the NSW Department of Education's policy on how to teach reading
- Remove lead from the environment
- Make the child's phonemic awareness normal
- Double the number of words in the child's sight vocabulary
- Add to the child's stock of grapheme-phoneme correspondence rules all the rules dealing with multiletter graphemes

Which would help the child ***right now***?

The RightNow criterion

Suppose a child is developmentally dyslexic. Which of the following actions could make an ***immediate*** difference to the child's reading performance?

- Repair chromosome 6
- Change the NSW Department of Education's policy on how to teach reading
- Remove lead from the environment
- Make the child's phonemic awareness normal
- Double the number of words in the child's sight vocabulary
- Add to the child's stock of grapheme-phoneme correspondence rules all the rules dealing with multiletter graphemes

Answer: only the blue ones

The RightNow criterion

Suppose a child is developmentally dyslexic. Which of the following actions could make an ***immediate*** difference to the child's reading performance?

- Repair chromosome 6
- Change the NSW Department of Education's policy on how to teach reading
- Remove lead from the environment
- Make the child's phonemic awareness normal
- Double the number of words in the child's sight vocabulary
- Add to the child's stock of grapheme-phoneme correspondence rules all the rules dealing with multiletter graphemes

Therefore the first four factors here involve distal causes and the last two involve proximal causes.

What might be the cause of specific language impairment?

Five subtypes of SLI

- ***Phonological Expressive Impairment*** subtype
- ***Verbal auditory agnosia*** subtype
- ***Lexical-syntactic*** subtype
- ***Grammatical*** subtype
- ***Semantic-pragmatic*** subtype

It is rare for an SLI child to show the characteristics of only a single subtype - so why subtype?

Because each subtype can occur in the absence of another subtype, so the subtypes must have separate psycholinguistic explanations, and separate biological explanations.

Conclusions

- Whenever cognitive testing reveals that a child is having difficulty acquiring some cognitive skill (e.g. reading), there will always be a causal chain involved.
- The link in the causal chain closest to the behavior - the ***proximal cause*** of the abnormality in behavior - is always describable at the cognitive level.
- So no attempt at a causal explanation of any developmental disorder of cognition which makes no reference to cognition itself can be complete.
- The proximal cause is also always a current characteristic of the child, whilst distal causes may often be states of the past, not of the present. Treatment needs therefore to focus on the proximal cause.