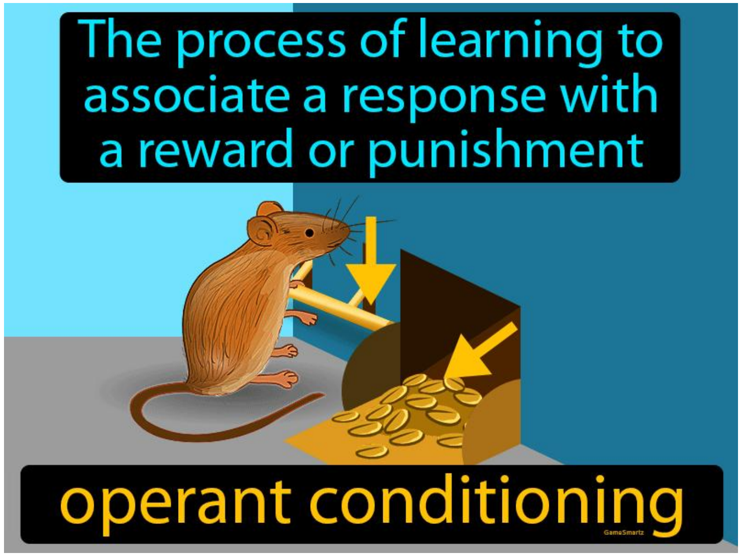
Week 8: language development

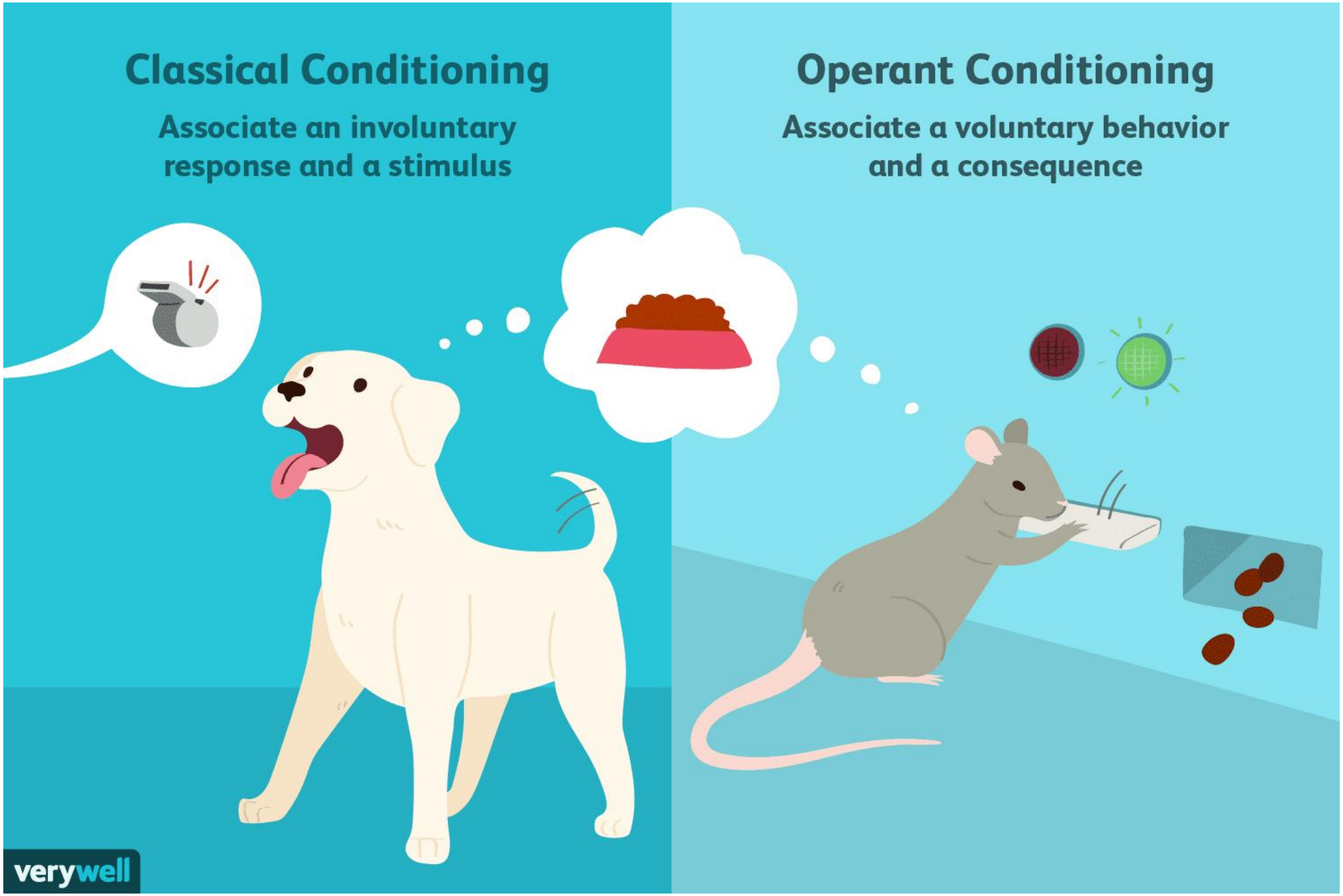
Imitation Theory

- Imitation Theory suggests that we are a product of our environment. Therefore, children have no internal mechanism or ability to develop language by themselves.
- BF Skinner (1957) suggests that children learn language first through imitating their caregivers (usually parents) and then modifying their use of language due to operant conditioning.

Theory of behavior

- Skinner‘s theory is based on operant conditioning (操作性条件发射)
- Reinforcement increases a behavior and punishment decreases or ends it. In other words, the consequences which follows a response determined whether the behavior will be repeated.




Classical Conditioning
Associate an involuntary response and a stimulus
Operant Conditioning
Associate a voluntary behavior and a consequence
verywell

Positive Reinforcement

Reinforcement = Do it again!

Positive = Adding something (good)

Positive Punishment

Punishment = Don't do it again!

Positive = Adding something (bad)

Negative Reinforcement

Reinforcement = Do it again!

Negative = Taking something (bad) away

Negative Punishment

Punishment = Don't do it again!

Negative = Taking something (good) away

Question

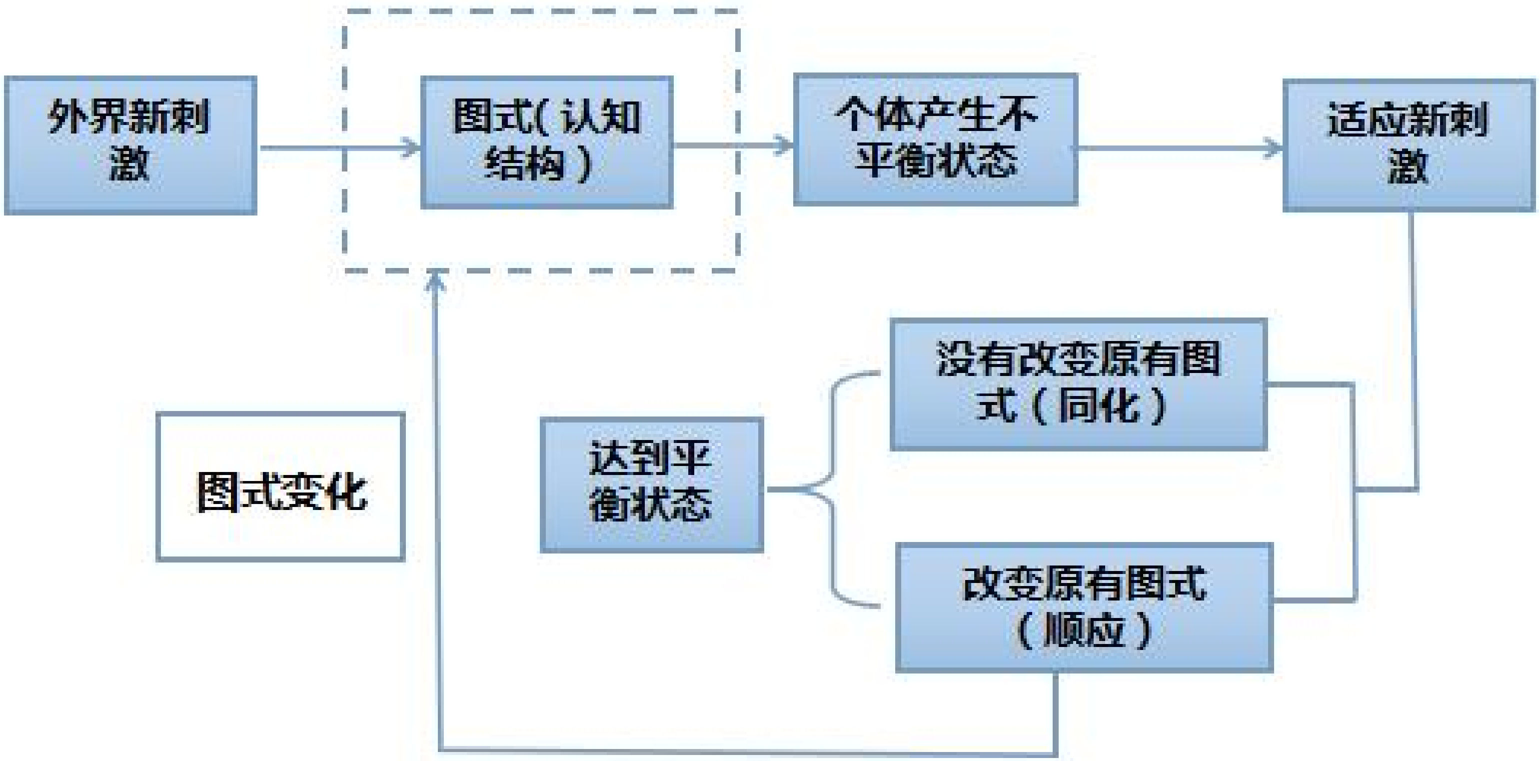
Operant Conditioning

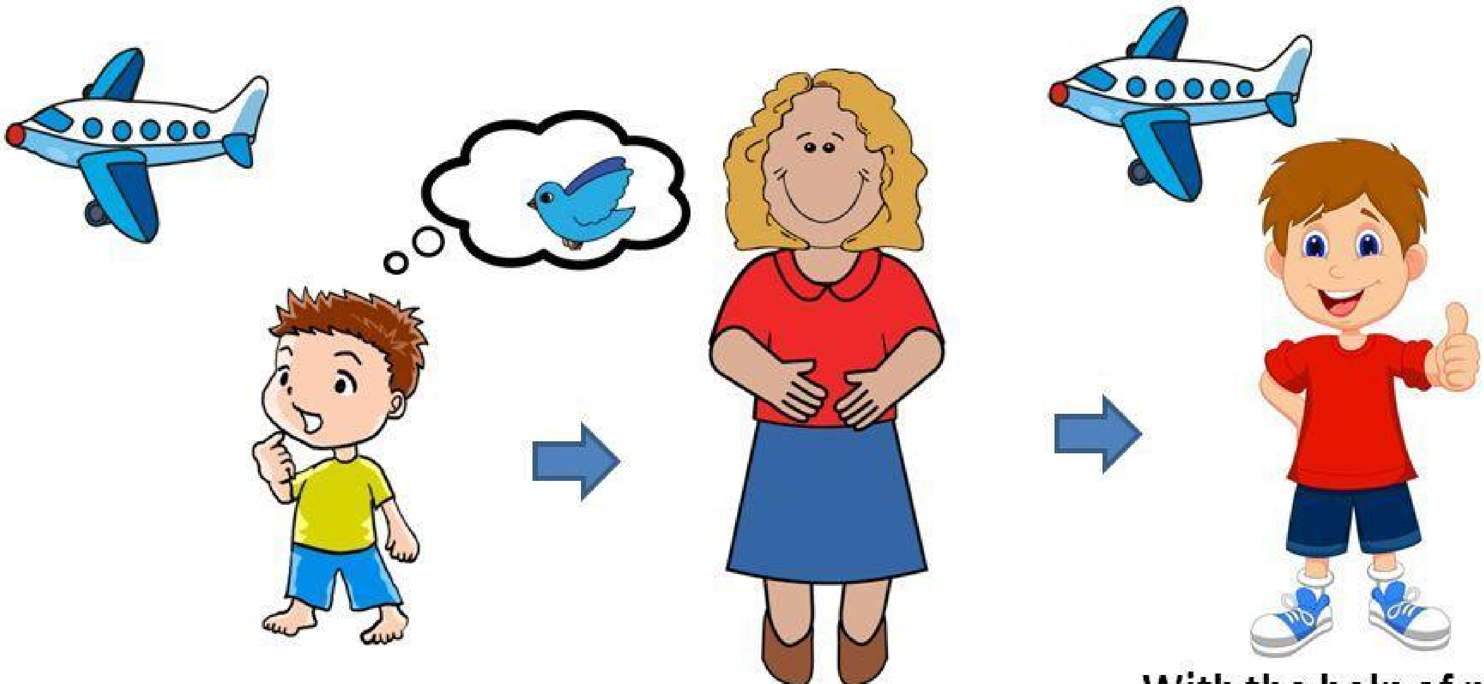
- A student skips class because she doesn't really like school. As a result, she is suspended.
- Is this a punishment or a reinforcement?

- Researchers argued that children would never acquire the tools needed for processing an infinite number of sentences if the language acquisition mechanism was dependent on language input alone.
  - Children often ignore language corrections
  - How a word learned in certain situation could be used in other?
  - How children produces sentences that they never heard before?

Cognitive theory

- Jean Piaget (1923) assumes that children are born with relatively little cognitive ability, but their minds develop and build new schemas (ideas and understanding of how the world works) as they age and experience the world around them.
- Eventually, they can apply language to their schemas through assimilation (同化 fitting new information into what is already known) and accommodation (顺应 changing one's schemas to support new information).


外界新刺激
图式(认知结构)
个体产生不平衡状态
适应新刺激
没有改变原有图式（同化）
达到平衡状态
改变原有图式（顺应）
图式变化



Boy saw an airplane and from existing schema he called it "BIRD", this is called *ASSIMILATION*

Mother told him It's an airplane and people travel in it and it's a Non-living thing.

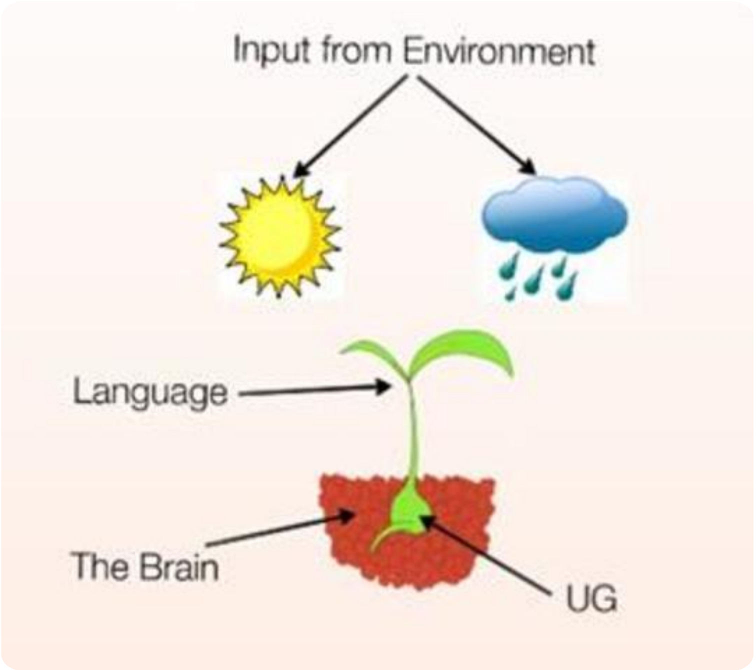
With the help of new schema, now boy came to know the difference of bird and airplane and now he can correctly recognize it. This called *ACCOMMODATION*

阶段	年龄	特征
感知运动阶段	0-2 岁	1.通过探索感知运动之间的关系来获得动作经验； 2.低级动作图式； 3.获得客体永恒性（9-12 个月）
前运算阶段	2-7 岁	1.万物有灵论； 2.一切以自我中心； 3.思维具有不可逆性、刻板性； 4.没有守恒概念； 5.做出判断只能运用一个标准或维度
具体运算阶段	7-11 岁	1.这个阶段的标志守恒观念的形成（守恒性）； 2.思维运算必须有具体事务支撑，可进行简单抽象思维； 3.理解原则和规则，但只能刻板遵守不敢改变； 4.儿童思维具有可逆性(儿童思维发展的最重要特征）
形式运算阶段	11-16 岁	1.能够根据逻辑推理、归纳或演绎方式来解决问题； 2.能够理解符号意义、隐喻和直喻，能作一定的概括； 3.思维具有可逆性、补偿性和灵活性

Innateness Hypothesis

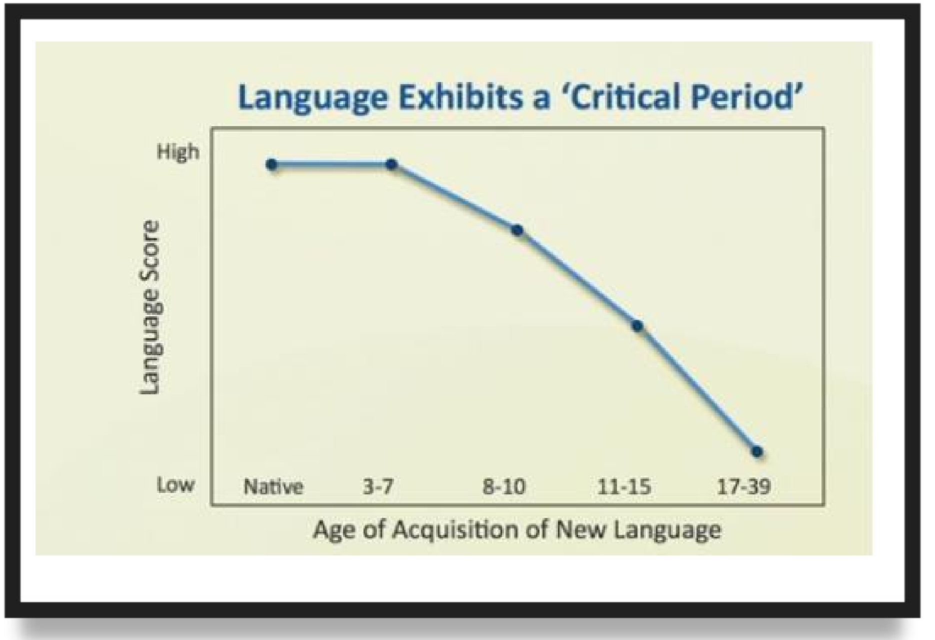
- **"Innateness Hypothesis"** of child language acquisition, proposed by Noam Chomsky, states that the humans are genetically programed for language.

- **Language Acquisition Device (LAD)**: Chomsky proposed that humans have an inborn biological capacity for language, often termed the LAD, which predisposes them to acquire language.
- **Universal Grammar**: He suggested that all human languages share a deep structure rooted in a set of grammatical rules and categories. This "universal grammar" is understood intuitively by all humans.



Critical period hypothesis

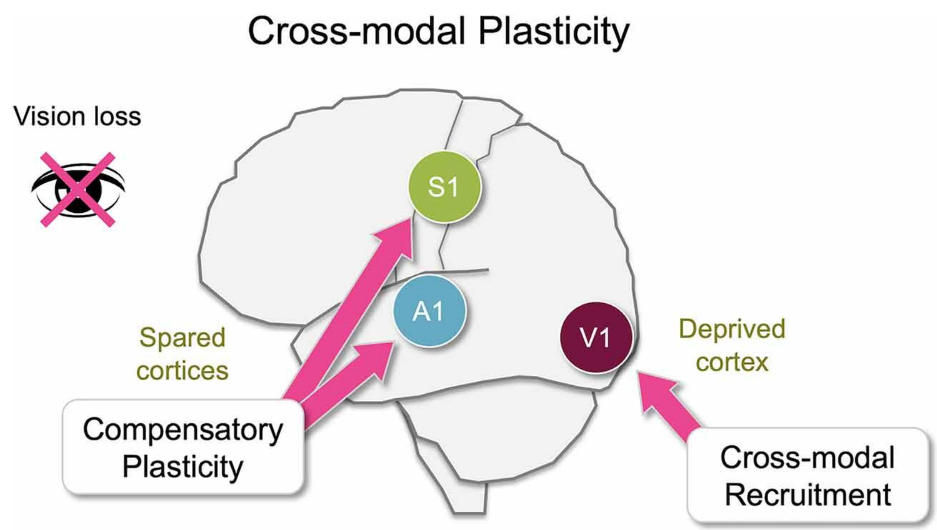
- Chomsky, along with other linguists, posited a critical period for language acquisition, during which the brain is particularly receptive to linguistic input, making language learning more efficient.
- An age after which it is almost impossible to acquire language with native speaker fluency
- A period of brain development after which language learning is no longer automatic



Evidence for critical period hypothesis

- Brain plasticity
- Fail to learn language

- Cross-modal re-assignment occurs when the brain uses an area that would normally process a certain type of sensory information for a different type of sensory information instead。
- When a brain region does not receive sensory data as expected, say because a person has become blind, this brain region may become repurposed for another sense, like touch.
- Also, some blind people learn to reuse their visual centers for hearing sounds, thus becoming capable of “echolocation”(回声定位) to navigate



Socially isolation

- Genie, the so-called ‘feral child’, is a key case study in regard to the critical period and language acquisition (released at 13).
- Isabelle, through intensive training and a stimulating environment, Isabelle improved so much that she was considered a child of normal intelligence by the age of eight (released at 6)

- Hartshorne, J. K., Tenenbaum, J. B., & Pinker, S. (2018). A critical period for second language acquisition: Evidence from 2/3 million English speakers. *Cognition*, *177*, 263-277.

Abstract

Children learn language more easily than adults, though when and why this ability declines have been obscure for both empirical reasons (underpowered studies) and conceptual reasons (measuring the ultimate attainment of learners who started at different ages cannot by itself reveal changes in underlying learning ability). We address both limitations with a dataset of unprecedented size (669,498 native and non-native English speakers) and a computational model that estimates the trajectory of underlying learning ability by disentangling current age, age at first exposure, and years of experience. This allows us to provide the first direct estimate of how grammar-learning ability changes with age, finding that it is preserved almost to the crux of adulthood (17.4 years old) and then declines steadily. This finding held not only for "difficult" syntactic phenomena but also for "easy" syntactic phenomena that are normally mastered early in acquisition. The results support the existence of a sharply-defined critical period for language acquisition, but the age of offset is much later than previously speculated. The size of the dataset also provides novel insight into several other outstanding questions in language acquisition.

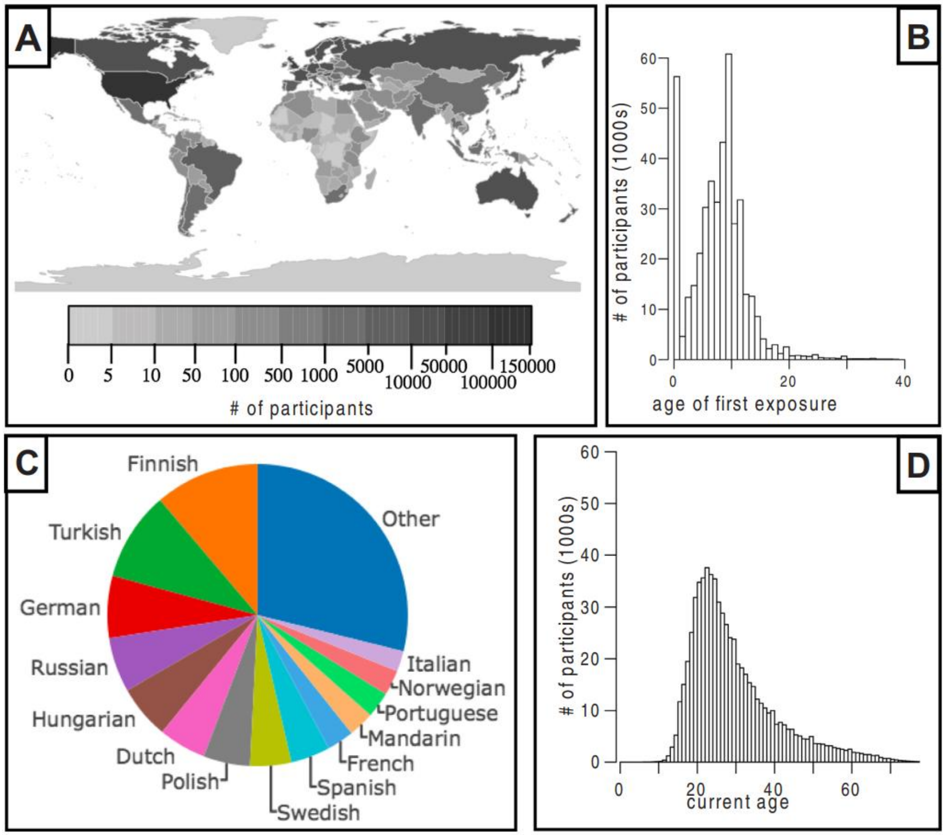
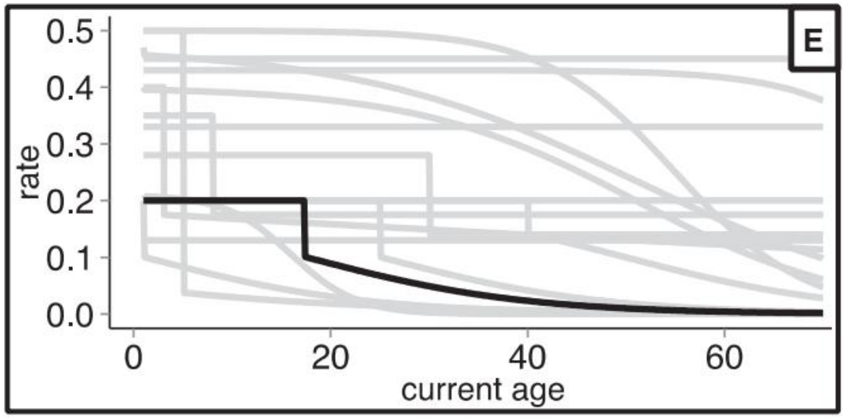


Fig. 3. (A) Current country of residence of participants (excluding participants with multiple residences). (B) Histogram of participants by age of first exposure to English. (C) Native languages of the bilinguals (excluding English). (D) Histogram of participants by current age.

- The most common native languages other than English were Finnish (N = 39,962), Turkish (N = 36,239), German (N = 24,995), Russian (N = 22,834), and Hungarian (N = 22,108).
- Monolinguals (N = 246,497) grew up speaking English only; Immersion learners (N = 45,067) ; Non-immersion learners (N = 266,701)

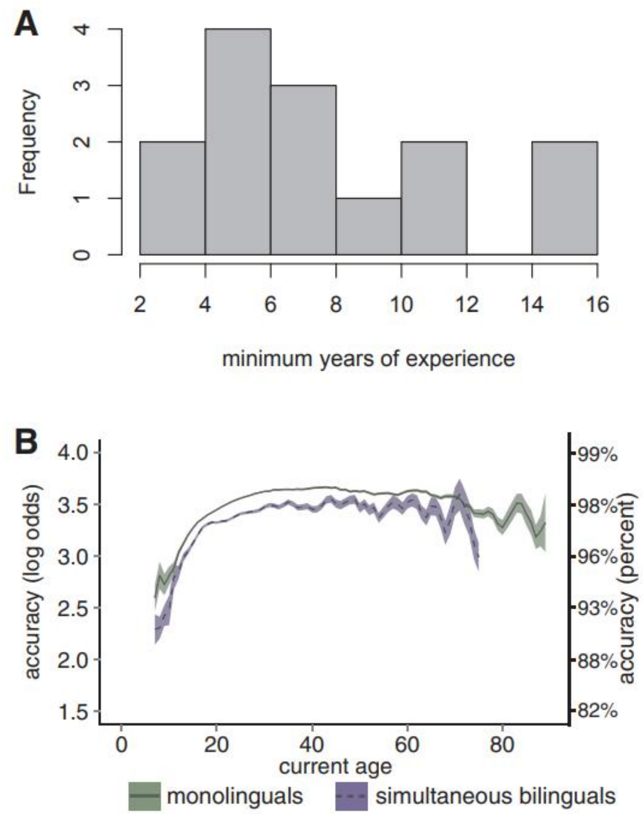
Learning rate

- Analyze whether the rate of L2 learning varies with the learner's age
- It was suggested that the learning rate started to decline at the age of 17.4 years old



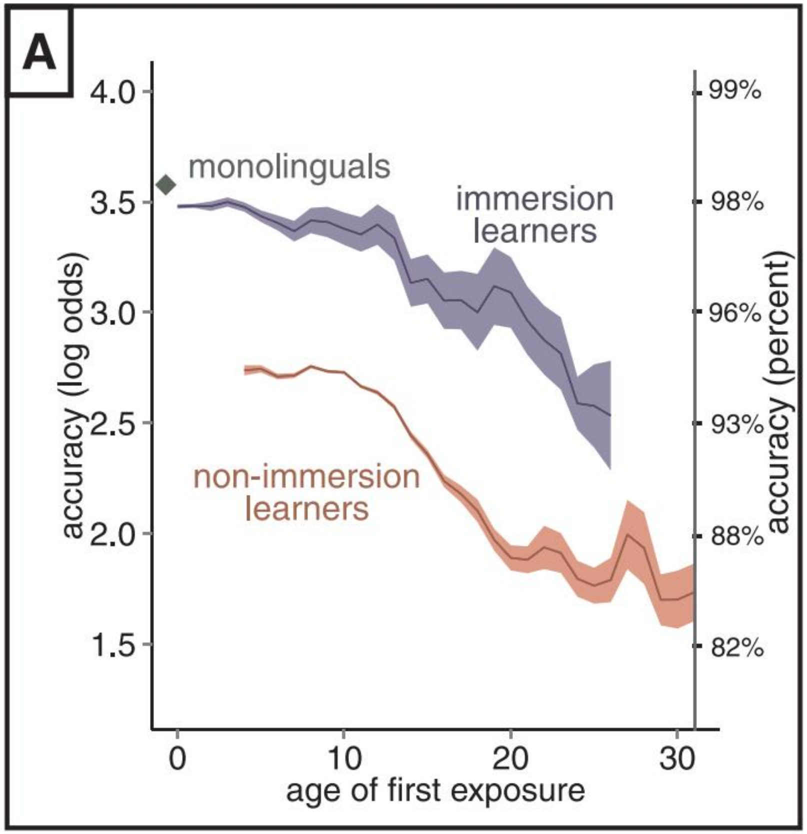
Duration of learning

- How long it takes learners to reach asymptotic (渐进的) performance
- It was suggested that native speakers did not reach asymptote until around 30 years old, though most of the learning takes place in the first 10–20 years.

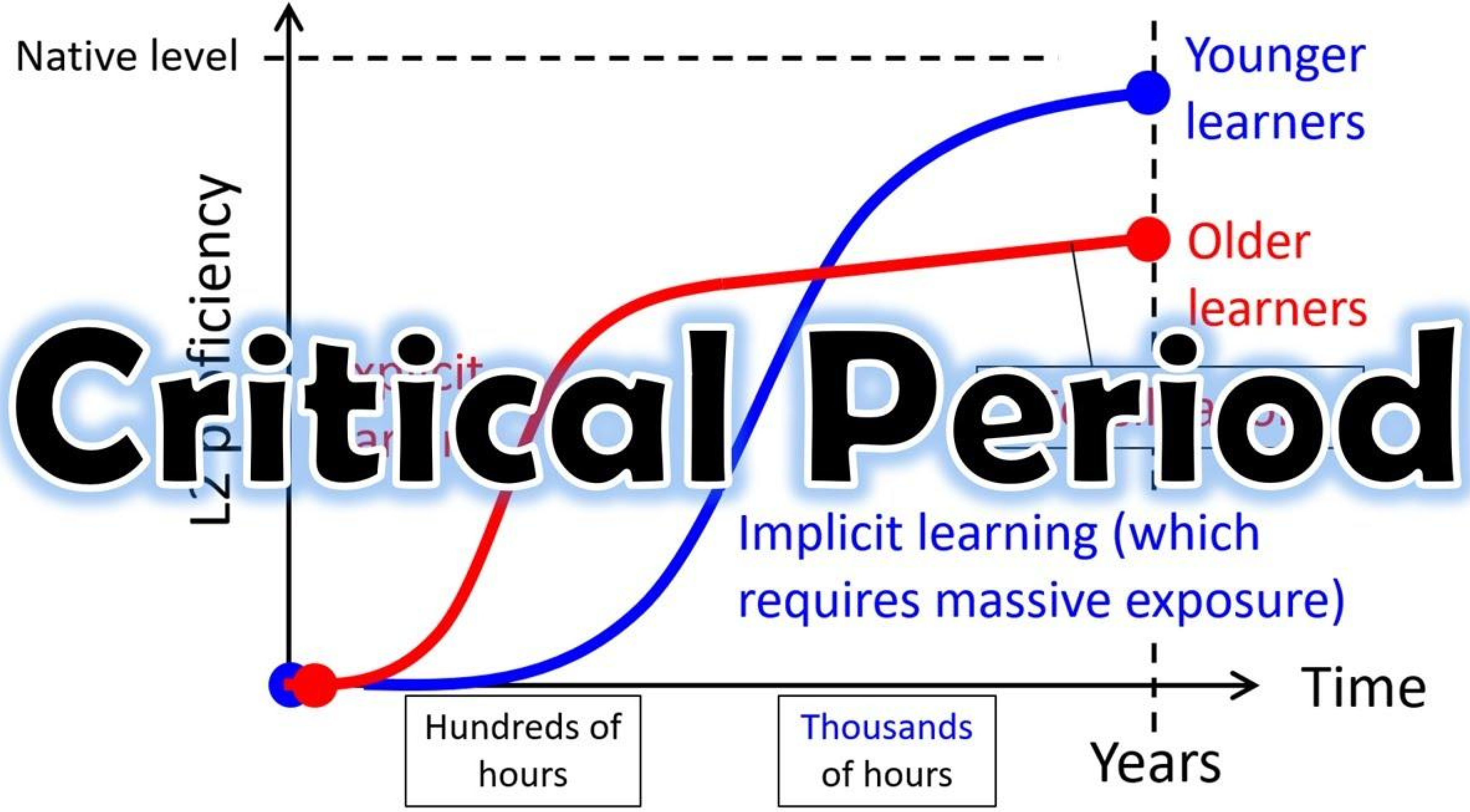


Ultimate attainment

- we analyzed ultimate attainment curves by focusing on the immersion and non-immersion learners who had at least 30 years of experience
- Immersion learners showed only a minimal decline in ultimate attainment until an age of first exposure of 12 years, after which the decline became significantly steeper.
- Non-immersion learners showed similar results: From 4 years to 9 years, proficiency showed no decline, followed by a steep decline



- Conclusion
  - The analyses above all point to a grammar-learning ability that is preserved throughout childhood and declines rapidly in late adolescence.
  - we found that native and non-native learners both require around 30 years to reach asymptotic performance, at least in immersion settings.
  - Ultimate attainment is consistent for learners who begin prior to 10–12 years of age.



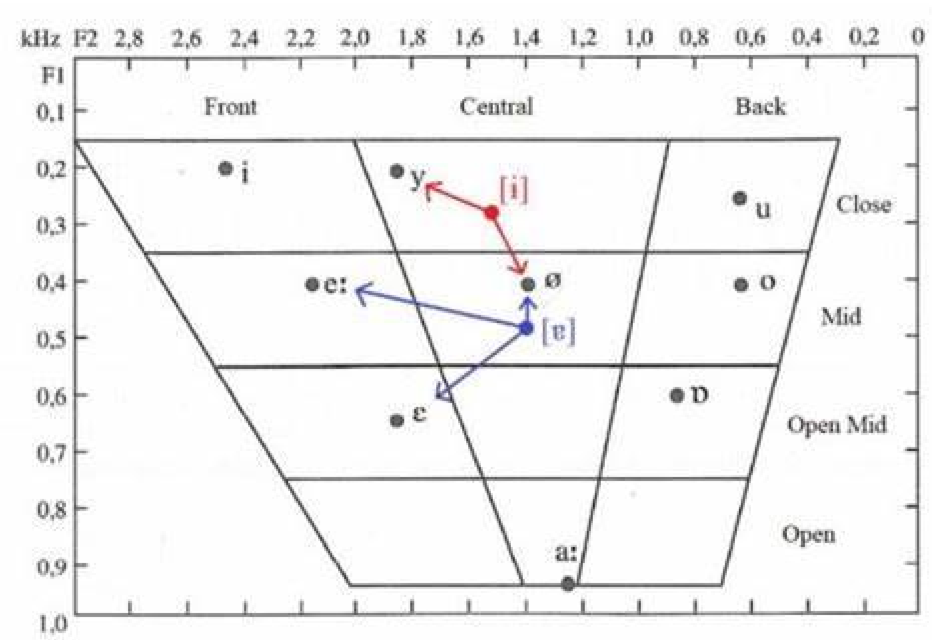
Critical Period
Native level
Younger learners
Older learners
L2 proficiency
Implicit learning (which requires massive exposure)
Time
Years
Hundreds of hours
Thousands of hours

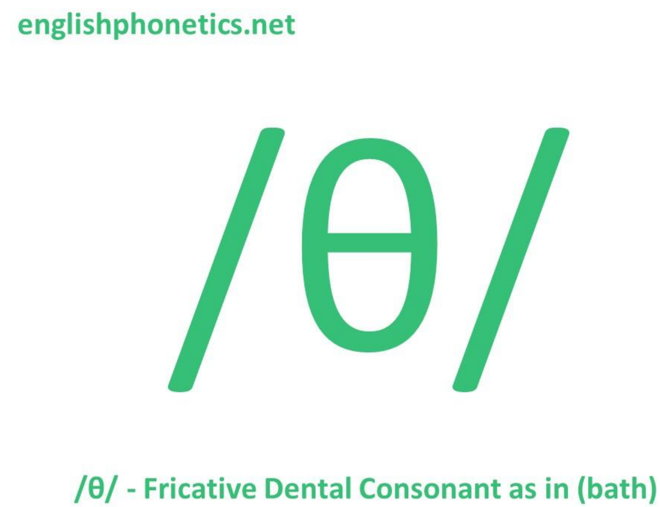
- Language transfer
  - Language transfer is the application of linguistic features from one language to another by a bilingual or multilingual speaker.
  - May occur across both languages of a simultaneous bilingual, from L1 to L2, or from L2 back to the L1
  - also known as L1 interference, linguistic interference

- Contrastive anaylsis (对比分析理论)
  - Contrastive analysis is the systematic study of a pair of languages with a view to identifying their structural differences and similarities
  - positive or negative transfer
    - phonology
    - lexical words
    - grammar

- Phonology
  - Speech learning model (Flege, 1992)
    - Foreign accents are caused, at least in part, by the inaccurate perception of sounds in an L2
    - The later the learner starts to learn L2, the lower their ability to perceive the difference between L1 and L2 is, and the greater the impact on L2 skills
  - The perceptual assimilation model (Best & Strange, 1992)
    - Rather than focusing on which individual sounds a learner will have trouble pronouncing or perceiving, it focuses on which pairs of sounds will be difficult
    - The two L2 sounds fit into two different L1 sounds categories: /l-r/.

- Perceptual space





  - L2 phoneme is assimilated to a L1 phoneme (or category) that is close enough
  - if there is no such phoneme in L1, L2 learners substituted the phoneme using a similar one in L1

- Lexical word
  - L2 words can activate L1 translation equivalents, i.e., the presence of L2-L1 translation priming effects (狗-bark)
  - As the proficiency level of the bilinguals increases, the need to refer to the L1 to communicate in the L2 decreases (Kroll et al., 2002)
  - Cognate effect
    - translations that share both form and meaning across languages (e.g., ‘paper’ and ‘papel’, in English and Spanish, respectively)
  - lemma package

- Grammar
  - measure words, gender, pluras etc.
  - second language (L2) learners exhibit optionality in their use of inflectional morphology, with tense and agreement markings sometimes being present and sometimes absent in L2 production data (Prévost & White, 2000)

Gender difference?

- In a sample of 18-month-olds infants, boys' average vocabulary size was 41.8 words (range from 0 to 222, SD= 50.1), while girls' average was 86.8 (range from 2 to 318, SD= 83.2).
- By 24 months, the difference had narrowed to a boys' mean of 196.8 (range 0 to 414, SD=126.8) vs. a girls' mean of 275.1 (range 15 to 415, SD=121.6).

- As time passes, the difference disappears entirely, and then emerges again in the opposite direction, with males showing larger average vocabularies during college years

Lutchmaya, S., Baron-Cohen, S., & Raggatt, P. (2001). Foetal testosterone and vocabulary size in 18-and 24-month-old infants. Infant Behavior and Development, 24(4), 418-424.

Social economic status?

- By age 3, children from privileged families have heard 30 million more words than children from underprivileged families.
- Longitudinal data on 42 families examined what accounted for enormous differences in rates of vocabulary growth. Children turned out to be like their parents in activity level, vocabulary resources, and language and interaction styles.
- Follow-up data indicated that the 3-year-old measures of accomplishment predicted third grade school achievement.

Families' Language and Use Differ Across Income Groups

	Families					
	13 Professional		23 Working-class		6 Welfare	
Measures & Scores	Parent	Child	Parent	Child	Parent	Child
Protest score[a]	41		31		14	
Recorded vocabulary size	2,176	1,116	1,498	749	974	525
Average utterances per hour[a]	487	310	301	223	176	168
Average different words per hour	382	297	251	216	167	149

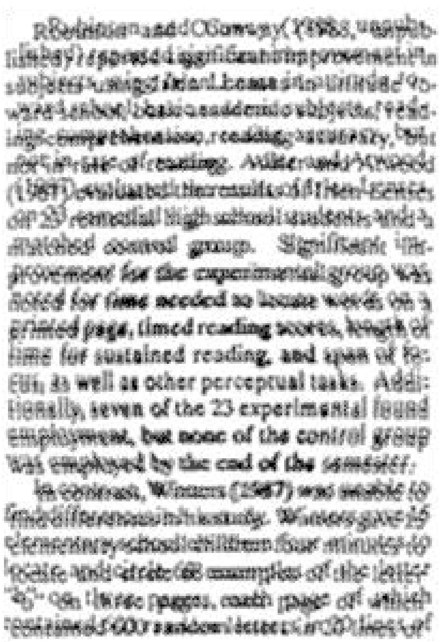
[a] When we began the longitudinal study, we asked the parents to complete a vocabulary protest. At the first observation each parent was asked to ...

Hart, B., & Risley, T. R. (2003). The early catastrophe: The 30 million word gap by age 3. *American educator*, *27*(1), 4-9.

Language related developmental disorder

- Developmental disorders comprise a group of psychiatric conditions originating in childhood that involve serious impairment in different areas.
  - These disorders comprise developmental language disorder, learning disorders, developmental coordination disorders, and autism spectrum disorders (ASD), attention deficit hyperactivity disorder (ADHD).
  - Physical or brain-based conditions that affect a child's progress as they grow and develop necessary life skills.
  - Reflect atypical development of some but not all aspects

- Outward manifestations of pediatric disorders have been linked to a complex interaction of multiple genes and epigenetic(表观遗传) factors, especially those related to language function
- Children with developmental disorders usually do not always have only one particular disability. Some children may be simultaneously diagnosed with dyslexia, attention deficit disorder, language disorder, and auditory processing disorder, or with any other possible combination of the disorders that commonly occur in childhood.



Dysliexa

A finerd who has dxleyisa dscbieerd to me how she eecpeexnirs meadig. She *can* read, but it takes a lot of ccireoonattnn, and the lerttes smees to "jmup aounrd".

I rebmeeemrd rdanieg aoubt tloymeygcipa. Wduoln't it be pibossle to do it literaetlvcny on a weitbse with Jiasacvrpt? Srue it would.

Feel like manikg a bkmaolorket of tihs or snimtoheg? Frok it on github.

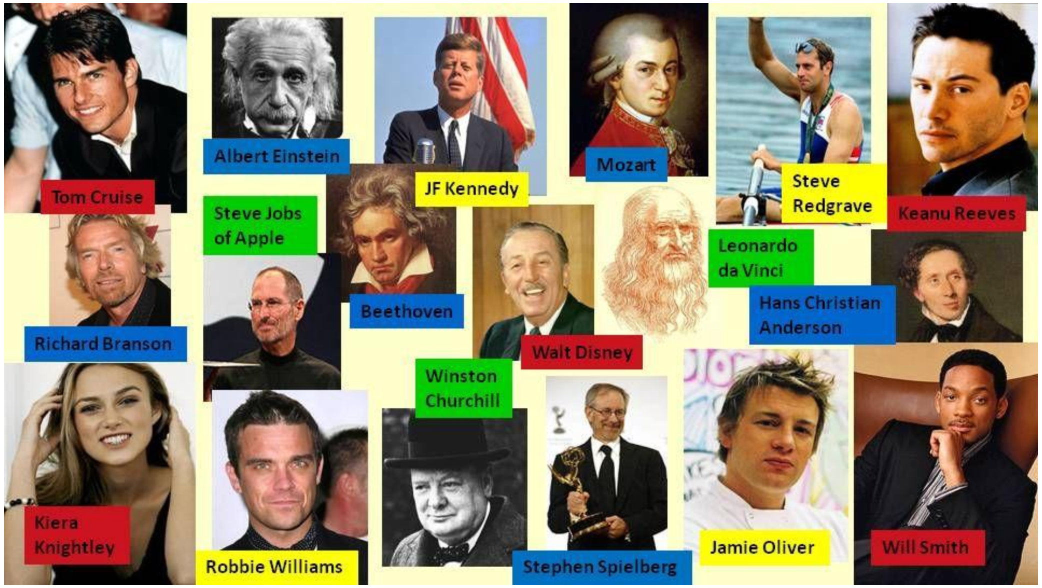
> Dlsxyiea is czchiateearrd by dtcfluiify wtih lnaernig to read flnletuy and with actaurce cmoireohsnepn disptee nraoml inelgnlcetie. This iedculns diuticffly with plgoahocoinl aasenwres, pngliohoacl deciodng, pssicroeng seped, ogarorhpithc cindog, ariuotdy sohrt-term momery, lgganuae sllkis/vreabl ceespomnorhin, and/or ripad namnig.

> Dnemoeptealvl radnieg deirodsr (DRD) is the msot comomn lnareing dilisabity. Dexylsia is the most recogeznid of raideng diresrdos, hveweor not all ridnaeg ddoirsers are lenikd to dxyilsea.

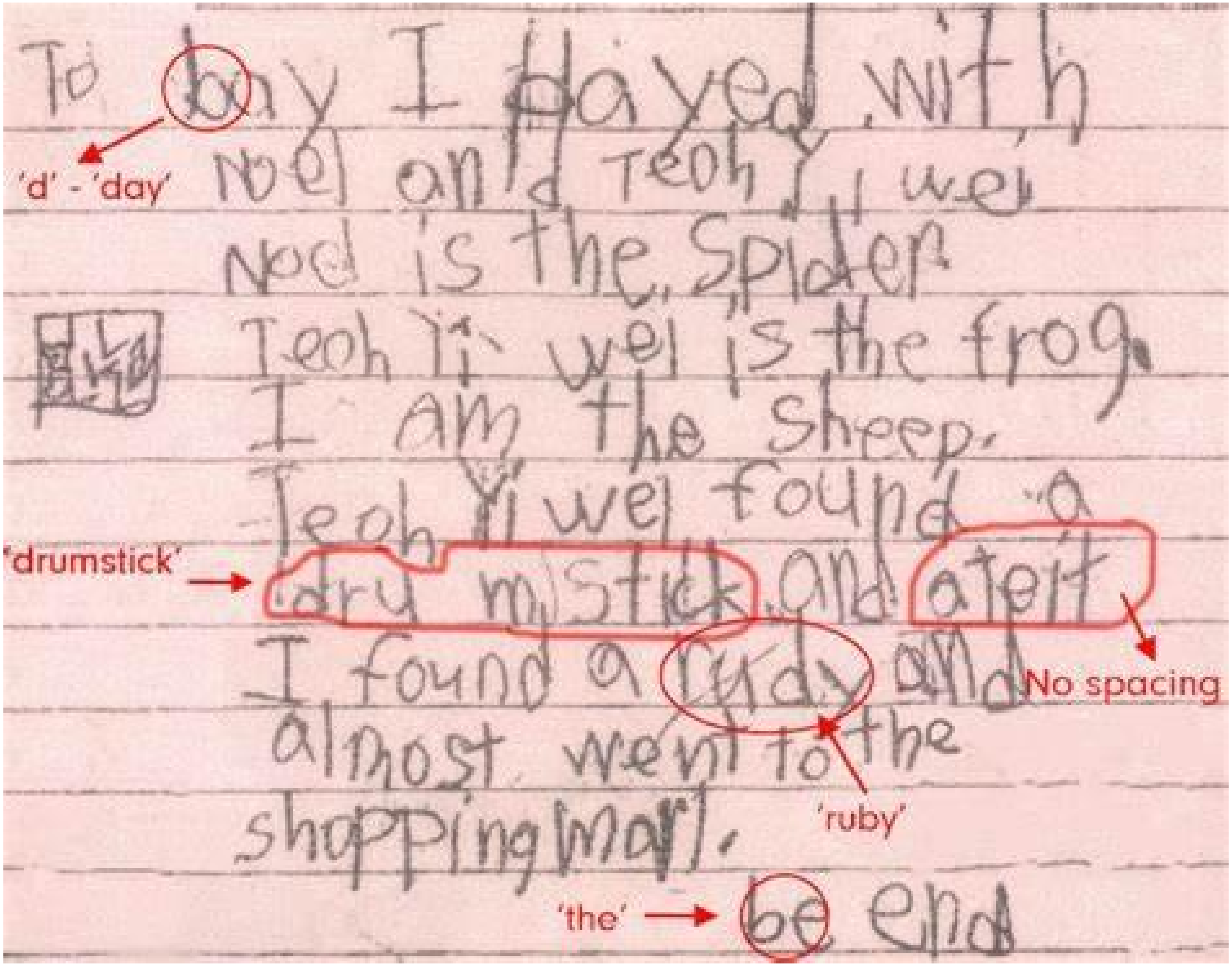
> Some see dyxesila as dnisctit form reiandg diffclltuies rielnstug form other ceuass, such as a non-noulgicaoerl dceeiifcny with vioisn or hneirag, or poor or iauanqtede rendiag iricstoutnn. Terhe are trhee poreospd cvintgioe syetpubs of deyislxa (aoirtudy, vuisal and aattnitneol), atouglhh ivuanididl cseas of delyxisa are btteer eenpxiald by speiicfc udnenylirg ngyuoherpaocisolcl dftiecis and co-ocrcnurig lnerniag deiibitslias (e.g. aneottitn-dieicft/hitctiepavryy dioesdrr, mtah dibiatlsiy, etc.). Autgohlh it is crodeinsed to be a reivtpece lnuggaae-besad lnraineg diilbaitsy in the rrceeash lrttraeiue, disyiexa aslo afetcfs one's erpxivssee lggnuaae slklis. Resrehaercs at MIT fonud that ploepe with deilsyxa ebeixtihd iraiepmd voice-rgncoetoiin aliteiibs.

Dyslexia

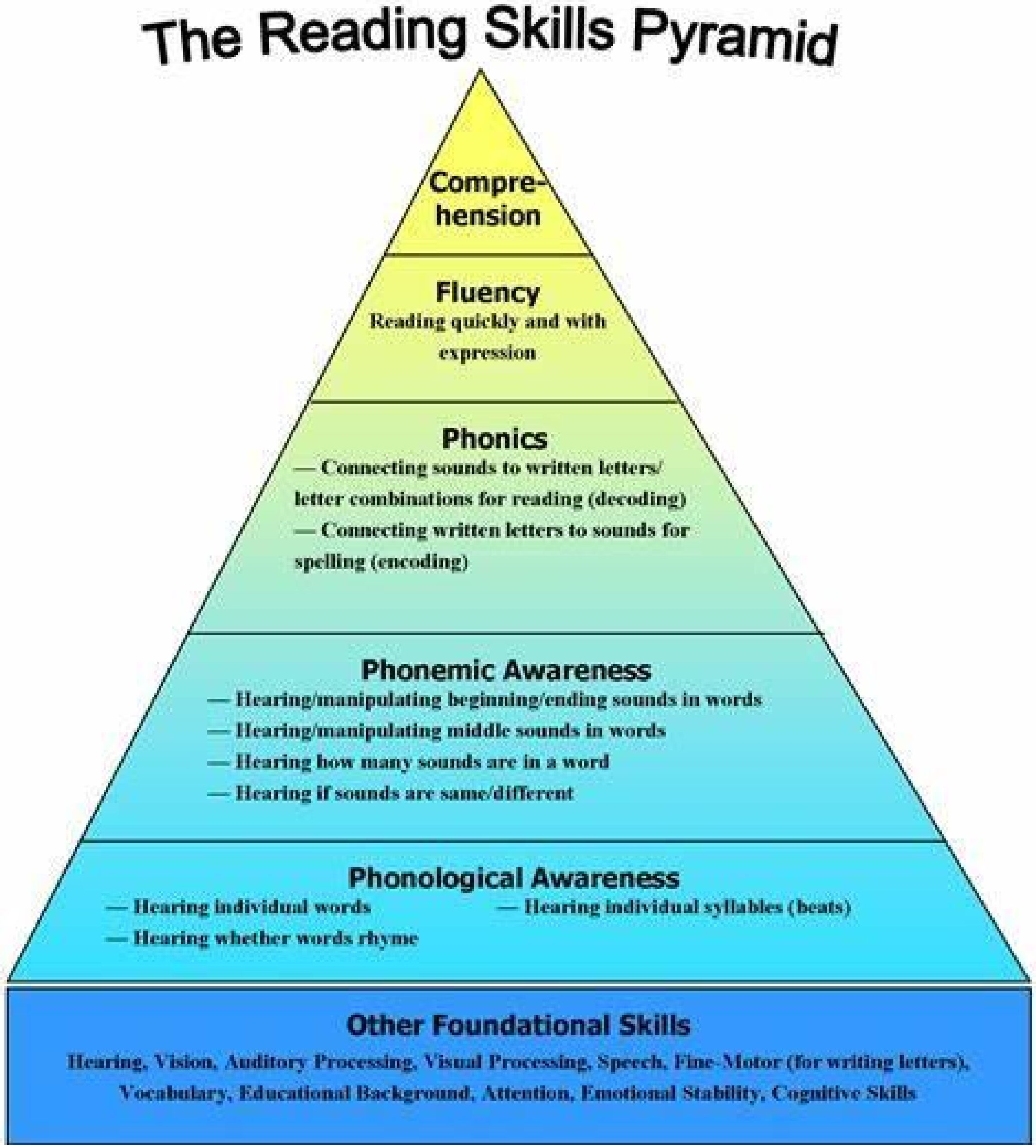
- Dyslexia is a common learning difficulty that mainly causes problems with **reading**, **writing** and **spelling.**
- Dyslexia affects a large number of people (5–10%).
- Unlike a learning disability, intelligence isn't affected.
- Dyslexia is a lifelong issue and tends to run in familes



- Signs of dyslexia even before children learn to read
  - rhyming or isolating sounds in word
  - phonemic awareness (the ability to hear, identify and manipulate the individual sounds that form words)
- Dyslexia
  - Reading well below the expected level for age
  - Problems processing and understanding what is heard
  - Problems remembering the sequence of things
  - Difficulty seeing similarities and differences in letters and words
  - Inability to sound out the pronunciation of an unfamiliar word
  - Difficulty spelling
  - a subgroup of dyslexic children exhibit visual perceptual deficits


To bay I playe with
Noel and Teoh Yi wei
Noel is the Spider
Teoh Yi wei is the frog
I am the sheep.
Teoh Yi wei found a
dru mstick and ateit
I found a rudy and
almost went to the
shopping mal.
be end
'd' - 'day'
'drumstick'
'ruby'
No spacing
'the'

Reading consists of two main basic processes: decoding and comprehension.



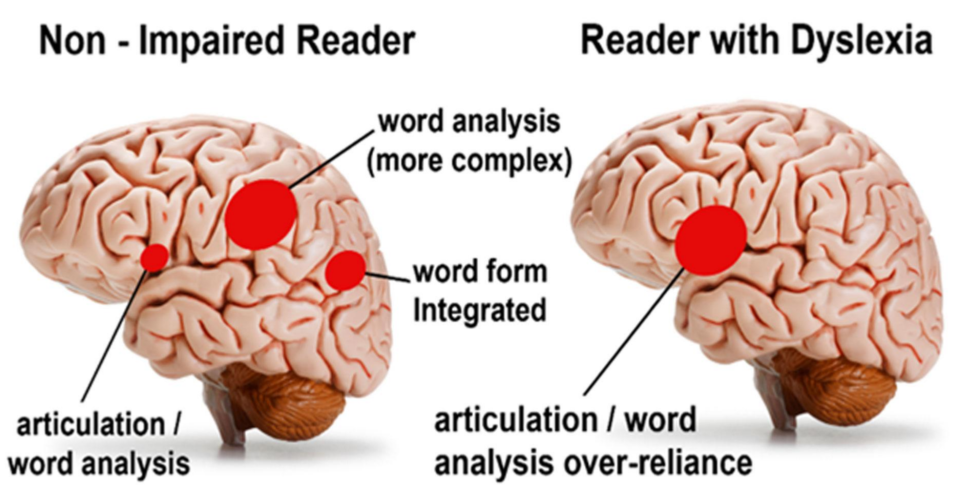
- Reading consists of two main basic processes: decoding and comprehension.
  - There is a strong consensus among investigators in the field that deficiency of the phonologic module.
  - This phonological awareness is strongly heritable. In dyslexia, because of the impairment in the phonologic module, patients are unable to decode and identify the word

- Neuroimaging techniques over several decades have opened windows into the brains of children diagnosed with a variety of developmental disorders.
- Brain-imaging studies have shown us there are differences in how the brain is structured and how it functions in people with dyslexia.
- More researchers have examined the brains of children and reported on the presence or absence of hemispheric asymmetries within specific diagnostic categories.

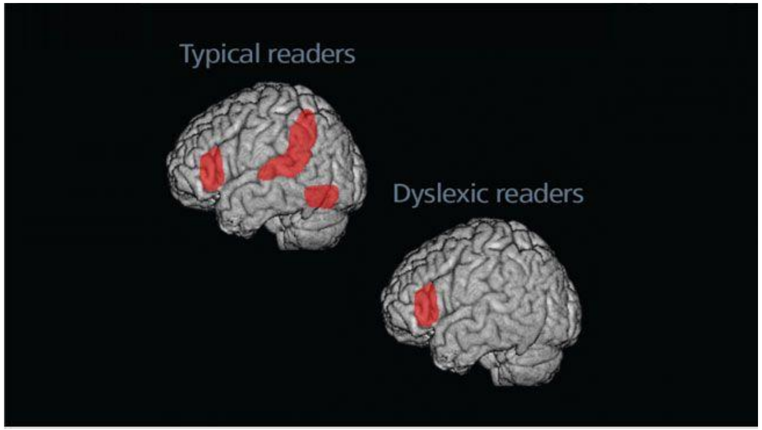
Abnormal brain activation of Dyslexia

For a typical reader, three parts of the brain are activated when they are reading:

- Broca's area
  - ➢ Broca's area, located at the front of the brain, is responsible for whole word processing (understanding a whole word)
- Parieto-temporal area
  - ➢ Left parieto-temporal area, located above the back ear, is responsible in decoding or breaking down a word (e.g. C+AT= CAT)
- Occipital-temporal area
  - ➢ Occipito-temporal area, located behind the ears towards the back part of the head, functions as the visual word-form area



- Researchers proposed associations between reading disorders and problems in the auditory system and phonological deficits, leading to a flurry of research into the linguistic determinants of dyslexia.
- A fairly consistent result has been that children with reading disorders demonstrate lower levels of activation in several left-hemisphere sites.



- An additional more consistent finding in dyslexia is the lack of planum temporale asymmetry that is important for language function.
- It has been hypothesized that this symmetry is due to reduced cell death during fetal development .
- This may result in an excess of neurons in the right planum that may contribute to miswiring of the brain. It is also possible that in dyslexics cortical auditory processing may be differently organized.

Hemispheric Asymmetry of Dyslexia

- In normal reading adults, 60–70% of the population shows a leftward asymmetry
- This study is the first to directly investigate planum temporale lateralization in individuals with and without a family history of dyslexia.
- Participants who had no family risk for dyslexia showing greater leftward asymmetry of the planum temporale. This effect was confirmed when analyses were restricted to normal reading participants.

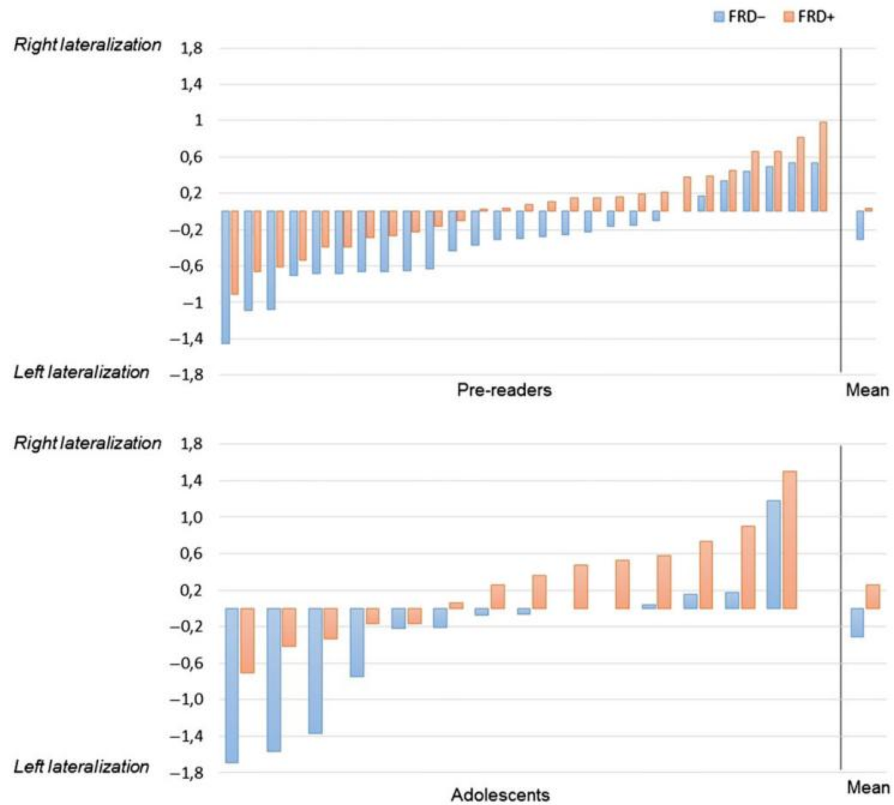
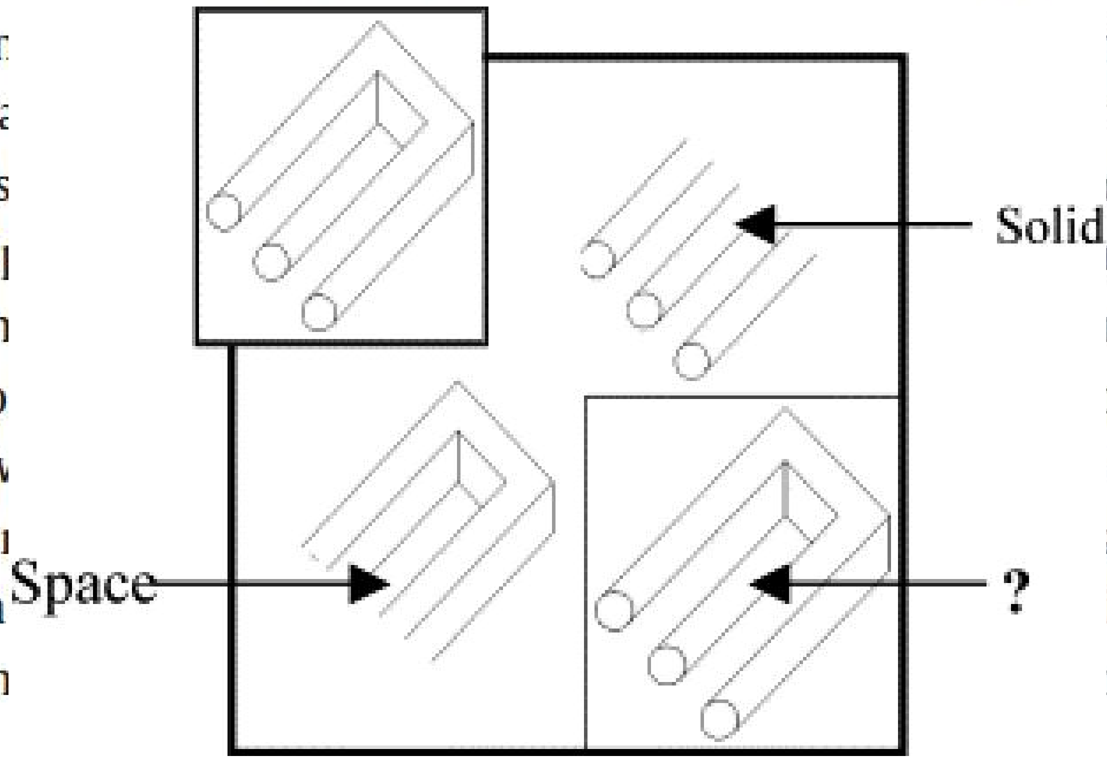


Figure 3. The normalized planum temporale AI for each pre-reader (top panel) and adolescent (bottom panel). Positive scores indicate a rightward planum temporale lateralization (right > left) and negative scores indicate a leftward lateralization (left > right). Within each group (blue = FRD$^-$, red = FRD$^+$) participants are ranked from low to high AI. In the right panel, mean lateralization is presented for each group.

Vanderauwera, J., Altarelli, I., Vandermosten, M., De Vos, A., Wouters, J., & Ghesquière, P. (2018). Atypical structural asymmetry of the planum temporale is related to family history of dyslexia. *Cerebral Cortex*, *28*(1), 63-72.

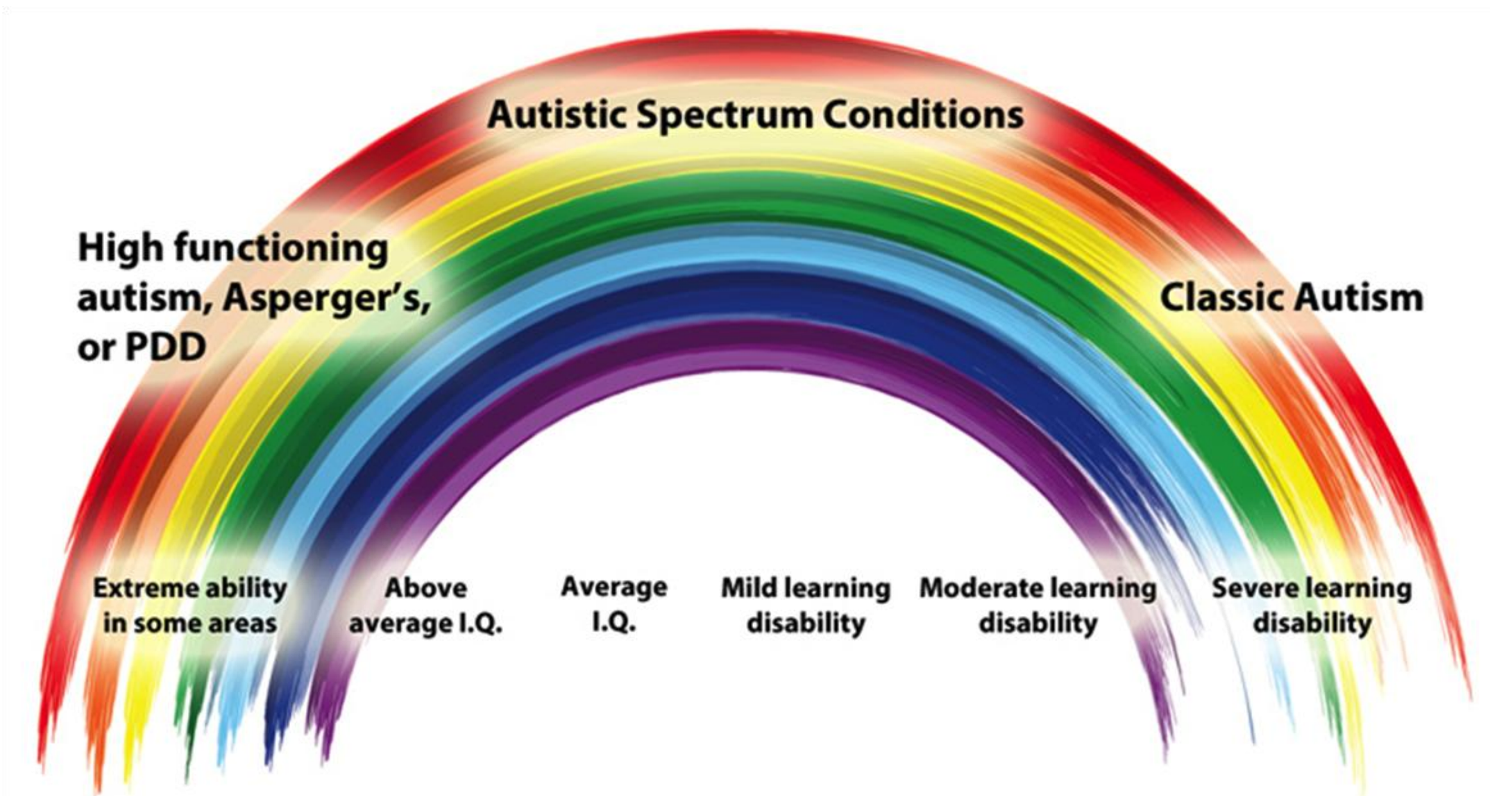
Von Karolyi, C., Winner, E., Gray, W., & Sherman, G. F. (2003). Dyslexia linked to talent: Global visual-spatial ability. *Brain and language*, *85*(3), 427-431.

Abstract

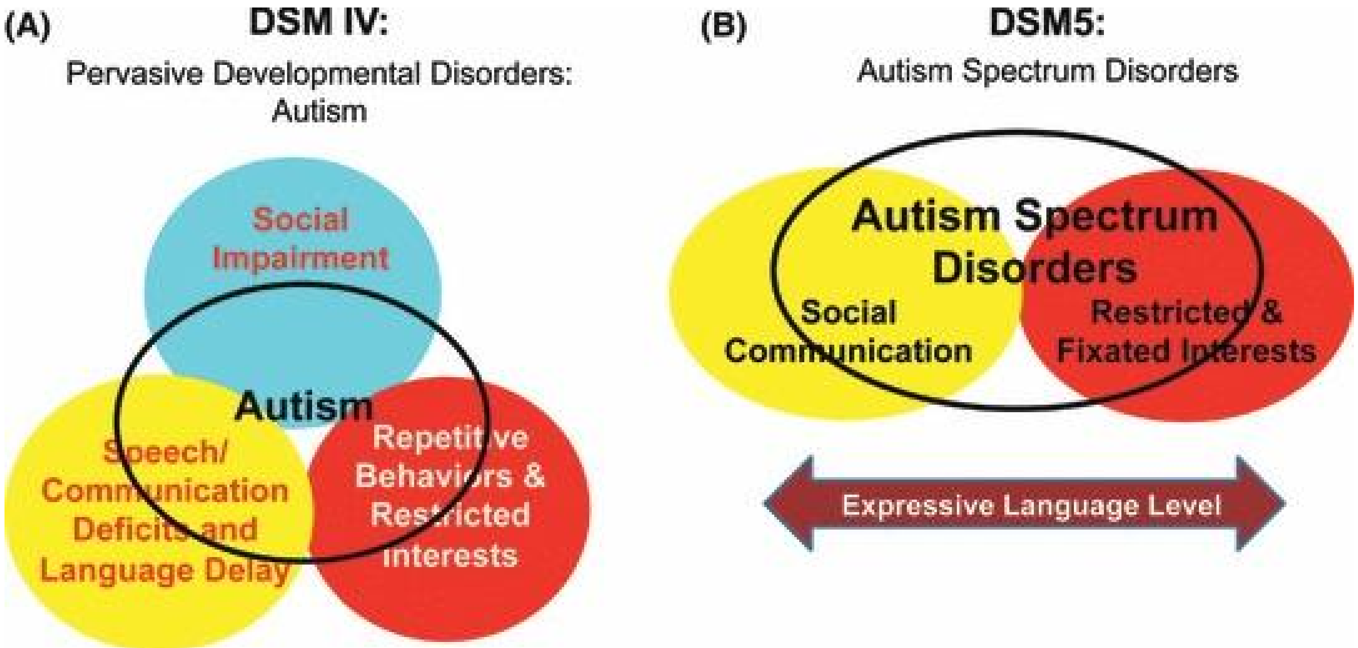


Dyslexia has lor … isual-spatial
talents accompa… th dyslexia
who possess vis… dyslexia in
certain visual-s… ere deficits
accompany righ… , inferior, and
average levels o…)
investigations, … recognition of
impossible figu… at dyslexia is
associated with … lity to process
visual-spatial in… t by part).

- Autism spectrum disorder
  - autism, Asperger’s syndrome, Pervasive developmental disorder not otherwise specified (PDD-NOS)



- Autism spectrum disorder
  - A neurodevelopmental disorder
  - is not a learning disability or illness
  - not because of bad parenting
  - the children with autism also had relatively low intelligence
  - Atypical behaviors starting early in development



- The Diagnostic and Statistical Manual of Mental Disorders, Version 5 (DSM-5)
- Symptoms
  – Impairments in social communication and interaction
  – Restricted and repetitive behaviors

- Hyper- or hypo-reactivity to sensory input
    - Apparent indifference to pain/temperature
    - Excessive smelling or touching of objects
    - Visual fascination with lights or movement
    - etc.

ASD > musician> normal people

✓ Absolute Pitch

✓ Relative Pitch

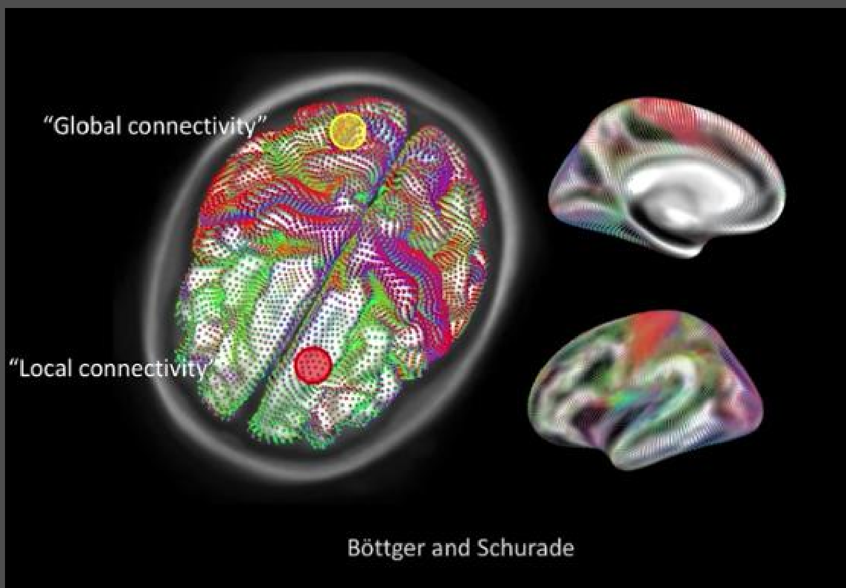
- Weak central Coherence (WCC, 弱中央统合)
  - ✓ Perceptual: a preference to process local information rather than global one
  - ✓ Conceptual: failure to process contextual meaning or use prior knowledge

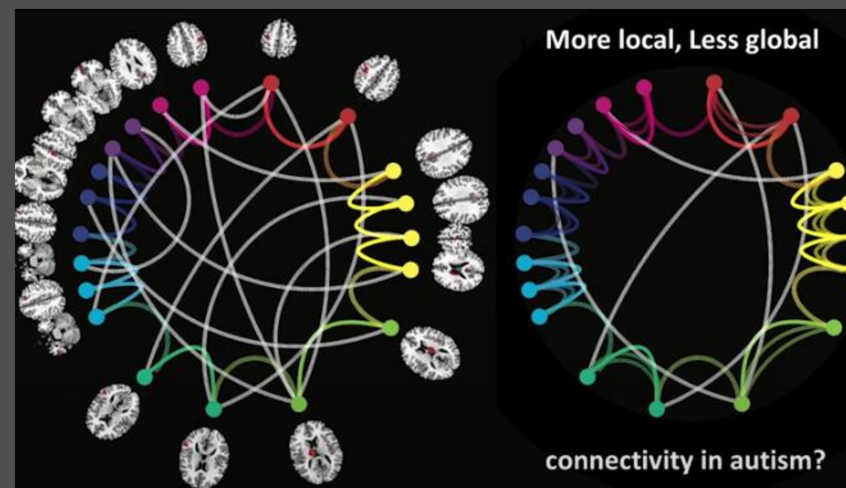
- Enhanced Perceptual Functioning (EPF,知觉功能促进) theory

  - ✓ Neural networks underpinning perceptual processing are ‘over-specialized’
  - ✓ Connections of brain regions, required by processing high-level perceptual functions, are impaired or under-developed

- Perception of non-speech pitch

  - ✓ Detail-focused style in sensory processing could generate advantages in perceiving non-speech pitch information
  - ✓ Language experience could also shape the sensitivity to the variation of pitch information


"Global connectivity"
"Local connectivity"
Böttger and Schurade


More local, Less global
connectivity in autism?

Fu, L., Wang, Y., Fang, H., Xiao, X., Xiao, T., Li, Y., ... & Ke, X. (2020). Longitudinal study of brain asymmetries in autism and developmental delays aged 2–5 years. *Neuroscience*, *432*, 137-149.

Abstract

Some previous studies have demonstrated atypical brain lateralization in autism spectrum disorder (ASD). However, most of these reports have focused on language-related asymmetries in adults, and the developmental trajectory of hemispheric asymmetries in the important phase that occurs at 2–5 years of age remains unclear. Thus, we used structural magnetic resonance imaging and diffusion tensor imaging (DTI) in a longitudinal study of grey matter (GM) asymmetries across all cortical parcellation units (PUs) and white matter (WM) lateralization across the WM skeleton using voxel-based morphometry and tract-based spatial statistics (TBSS) in 34 toddlers with ASD and a matched group of 26 toddlers with developmental delay (DD) at 2–3 years old and with follow-up at 4–5 years of age. We found the total brain volume and fractional anisotropy (FA) of WM was higher in the ASD group than in the DD group at baseline and 2 years later. The ASD and DD groups showed a rightward asymmetry in a large number of cortical PUs and in the WM skeleton at both time points. GM lateralization was associated with the social and communicative disturbances observed in ASD at baseline, while WM asymmetry was significantly related to social disturbances and repetitive behaviours seen at 4–5 years of age. In conclusion, both ASD and DD toddlers had widespread rightward asymmetry, and the patterns of lateralization were similar across the groups. GM and WM showed asynchronous development of hemispheric asymmetries at 2–5 years of age, and this lateralization was associated with ASD symptoms.

ARTICLE Open Access

Genetic evidence of gender difference in autism spectrum disorder supports the female-protective effect

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Abstract

Autism spectrum disorder (ASD) is a complex neurodevelopmental disorder with a male-to-female prevalence of 4:1. However, the genetic mechanisms underlying this gender difference remain unclear. Mutation burden analysis, a TADA model, and co-expression and functional network analyses were performed on de novo mutations (DNMs) and corresponding candidate genes. We found that the prevalence of putative functional DNMs (loss-of-function and predicted deleterious missense mutations) in females was significantly higher than that in males, suggesting that a higher genetic load was required in females to reach the threshold for a diagnosis. We then prioritized 174 candidate genes, including 60 shared genes, 91 male-specific genes, and 23 female-specific genes. All of the three subclasses of candidate genes were significantly more frequently co-expressed in female brains than male brains, suggesting that compensation effects of the deficiency of ASD candidate genes may be more likely in females. Nevertheless, the three subclasses of candidate genes were co-expressed with each other, suggesting a convergent functional network of male and female-specific genes. Our analysis of different aspects of genetic components provides suggestive evidence supporting the female-protective effect in ASD. Moreover, further study is needed to integrate neuronal and hormonal data to elucidate the underlying gender difference in ASD.