INTERDISCIPLINARY ADVANCES IN STATISTICAL LEARNING

June 10th –12th, 2026

DONOSTIA-SAN SEBASTIAN

BASQUE COUNTRY, SPAIN

PROGRAM SUMMARY

Wednesday, June 10th

08:00 – 08:45
Registration & Welcome Coffee

08:45- 09:00
Opening Remarks

09:00-09:50
Keynote 1: Jenny Saffran

09:50 – 11:10
Oral Session 1: SL and Cognitive Abilities
1. Franzoia (09:50-10:10)
2. Janssens (10:10-10:30)
3. Daikoku (10:30-10:50)
4. Zhou (10:50-11:10)

11:10 – 11:40
Coffee Break

11:40 – 13:10
Symposium 1: SL and neurobiology
1. *Theme Speaker* Inbal Arnon (11:40-12:10)
2. Andics (12:10-12:30)
3. Tramm (12:30-12:50)
4. Malassis (12:50-13:10)

13:10 - 15:00
Lunch break*

15:00 - 16:00
Oral Session 2: Theoretical perspectives
1. Holt (15:00-15:15)
2. Rueckl (15:15-15:30)
3. Rastle (15:30-15:45)
4. Németh (15:45-16:00)

16:00 - 16:20
Poster Blitz I

16:20 – 18:00
Poster Session I & Coffee Break

Thursday, June 11th

09:00 – 09:50
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09:50 – 10:50
Oral Session 3: Development
1. Forest (09:50-10:10)
2. Karmazyn-Raz (10:10-10:30)
3. Isbilen (10:30-10:50)

10:50 – 11:20
Coffee Break

11:20 – 13:10
Symposium 2: Computation and language
1. *Theme speaker* Marc Joanisse (11:20-11:50)
2. Emmorey (11:50-12:10)
3. Bojun (12:10-12:30)
4. Qi (12:30-12:50)
5. Vasudevamurthy (12:50-13:10)

13:10 - 15:00
Lunch break*

15:00 – 16:30
Symposium 3: SL and language
1. *Theme speaker* Patrick Rebuschat (15:00-15:30)
2. Monaghan (15:30-15:50)
3. Frinsel (15:50-16:10)
4. Arnold (16:10-16:30)

16:30 – 16:50
Poster Blitz II

16:50 – 18:30
Poster Session II & Coffee Break

Friday, June 12th

9:00 – 9:50
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09:50 – 10:50
Oral Session 4: SL and cognitive abilities II
1. Batterink (9:50-10:10)
2. Finn (10:10-10:30)
3. Dolci (10:30-10:50)

10:50 – 11:10
Poster Blitz III

11:10 – 13:10
Poster Session III & Coffee Break

13:10 - 14:30
Lunch break*

14:30 – 16:00
Symposium 4: SL and learning mechanisms
1. *Theme speaker* Marco Marelli (14:30-15:00)
2. Cabiddu (15:00-15:20)
3. Tirou (15:20-15:40)
4. Njoo-Deplante (15:40-16:00)

16:00 – 16:30
Coffee Break

16:30 - 17:20
Early career talk: Noam Siegelman

17:20 - 18:00
Closing remarks & Round table

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CONFERENCE DINNER **
20:00 Bus "Parroquia de San Sebastián Mártir" church – Cider House
20:30 Conference Dinner
23:30 Bus Cider House – Donostia

* Lunch on your own at one of the nearby bars or restaurants

** For Conference Dinner Attendees ONLY

WELCOME

Dear colleagues,

We want to extend a warm welcome to all of you joining us for the sixth edition of the *Interdisciplinary Advances in Statistical Learning Conference (#IASL26)* in beautiful San Sebastián.

It is hard to believe that it has now been 11 years since the first edition of the conference, when we first sought to provide an interdisciplinary, single-track forum for international researchers to share their perspectives and advance our collective understanding of statistical learning. When designing the first conference, we lacked data on how much interest there would be in the conference or in future editions thereof, but there is no longer any doubt—in this latest edition, we have received the highest total number of submissions in the conference's history. Some of these submissions are from stalwart researchers who have been with us from the very first edition, and many others are from researchers joining us for the first time. To all, we wish you a very hearty welcome and we hope that you will all enjoy the recurrent patterns of exciting presentations, engaging discussions, and warm hospitality of the Basque Country.

There have been innumerable advances in the statistical learning literature in the past decade, but, as with so many domains of inquiry, each answer has brought with it several new questions as well. What is unquestionable at this point, however, is that fully understanding how diverse learners extract regularities across time and space will be greatly facilitated by interdisciplinary perspectives that leverage the theoretical and methodological possibilities afforded by a range of stakeholders in this domain. Our various talk sessions, which cover a range of topics including theoretical perspectives, deep dives into particular domains, and broader methodological considerations, are designed to highlight the diverse knowledge we can bring to bear in developing a comprehensive understanding of statistical learning.

WELCOME

This international conference would not have been possible without the support of the *Basque Center on Cognition, Brain and Language* (BCBL). We want to thank Leire Arietaleanizbeascoa, Oihana Vadillo as well as other BCBL staff and students who are assisting with innumerable aspects of the conference. We also gratefully acknowledge funding provided by the Sociedad Española de Psicología Experimental (SEPEX), the Basque Government.

We hope you enjoy the conference!

Blair Armstrong, Louisa Bogaerts, Ram Frost, Morten Christiansen, and Manuel Carreiras
Statistical Learning Organizing & Scientific Committee

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09:50 - 11:10 Oral Session 1: SL and Cognitive Abilities

09:50 - 10:10 (OS-1.1.) Neural tracking of the rhythmic beat: a window on the detection of non-adjacent dependencies in adults and school-aged children. *Bianca Franzoia, Matthew O' Connor, Nicola Molinaro, Beatriz de Diego Lazaro & Ruth de Diego Balaguer*

10:10 - 10:30 (OS-1.2.) Statistical Learning and Mathematics: Are Different Domains and Modalities of Statistical Learning Related to Different Math Skills? *Michelle C. Janssens, Liv Smets, Eleonore H.M. Smalle, Arnaud Szmalec & Bert Reynvoet*

10:30 - 10:50 (OS-1.3.) From Prediction to Feeling: The Embodied Predictive Dynamics in the Statistical Learning of Music. *Tatsuya Daikoku*

10:50- 11:10 (OS-1.4.) Probing the role of statistical learning in language abilities with an individual differences approach. *Haoyu Zhou, Fabienne Chetail, Marc Brysbaert, Aaron Vandendaele & Louisa Bogaerts*

11:10 - 11:40 Coffee break

11:40 - 13:10 Symposium 1 Evolution and Cross-Species Perspectives on SL

11:40 - 12:10 (S-1.1.) Theme Speaker Inbal Arnon. Cultural evolution creates language-like structure: from humans to humpback whales and beyond

12:10 - 12:30 (S-1.2.) Dog puppies, pigs, and wild boars do not track complex statistical patterns in speech as adult dogs do. *Attila Andics, Kinga G.Tóth, Kitti Szabó & Marianna Boros*

12:30 - 12:50 (S-1.3.) Recursive Statistical Learning in Adults, Children, and Monkeys. *Elijah Tramm & Stephen Ferrigno*

12:50 - 13:10 (S-1.4.) Disentangling implicit from explicit sequence learning in primates. *Raphaelle Malassis, Laura Moscado, Jerome Sackur & Dezső Németh*

CONFERENCE PROGRAM – WEDNESDAY, JUNE 10th

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15:15 - 15:30 (OS-2.2.) Challenges to a Statistical Learning Approach to Reading. *Jay Rueckl*

15:30 – 15:45 (OS-2.3.) Morpheme Learning in the Noisy Landscape of Natural Text. *Kathy Rastle*

15:45 – 16:00 (OS2.4) Resolving Core Debates in Statistical Learning: Moving Beyond the Myth of Process Purity. *Dezső Németh*

16:00 - 16:20 Poster Blitz I

Presenting "Mega-SL": A Large-Scale, Open Dataset for Statistical Learning Research. *Natan Ilani Shames, Nadav Weisler & Noam Siegelman*

How underlying statistical structures modulate the neural response to rapid auditory sequences. *Alice Milne, Buse Adams & Maria Chait*

Early sensitivity to zipfian structure: skewed distributions facilitate statistical word segmentation in infants. *Lucie Wolters, Mitsuhiko Ota & Inbal Arnon*

Decoding Patterns: EEG Insights into Auditory Statistical Learning in Norwegian Children. *Giulia Zantonello, Fatih Sivridag, Valentin Vulchanov & Mila Dimitrova Vulchanova*

Language Learning in a Stressful World: The role of Autonomic Nervous System Reactivity in Statistical Learning from Speech. *Aliva Sholihat, Risto Halonen, Riikka Möttönen & Anu-Katriina Pesonen*

Flexible statistical learning across modalities: Online and offline measures reveal different aspects of adaptation to changing regularities. *Brent Vernaillen & Louisa Bogaerts*

16:20 - 18:00 Poster Session I & Coffee break

CONFERENCE PROGRAM – THURSDAY, JUNE 11th

09:00 - 09:50 **Keynote Speaker 2: Pierre-Yves Oudeyer.** Curiosity in human statistical learning: computational theories, experiments and applications in AI and education

09:50 - 10:50 **Oral Session 3: Development**

09:50 - 10:10 (OS-3.1.) Early Caregiver Predictability and the Developmental Origins of Individual Differences in Statistical Learning. *Tess Forest, Khula Study Team, Laurel Gabard-Durnam, Kirsten Donald & Dima Amso*

10:10 - 10:30 (OS-3.2.) Like sponges: children's self-generated interactions soak optimal statistics for learning. *Hadar Karmazyn-Raz & Linda B. Smith*

10:30 - 10:50 (OS-3.3.) Word search measures visual statistical learning and reading in children. *Erin Isbilen, Noam Siegelman, Jay Rueckl, Kenneth Pugh & Richard Aslin*

10:50 - 11:20 **Coffee break**

11:20 - 13:10 **Symposium 2: Computation and Language**

11:20 - 11:50 (S-2.1.) *Theme Speaker* Marc Joanisse. Statistical language learning in a quasi-regular world

11:50 - 12:10 (S-2.2.) Deaf readers' sensitivity to orthographic statistics: Evidence from a word search task. *Karen Emmorey, Enza Visco, Allison Bassett & Erin Isbilen*

12:10 - 12:30 (S-2.3) Developmental approach reveals the statistical learning pattern of neural language models: transformers generalize from the most global distributional patterns. *Wang Bojun, Holly Jenkins & Elizabeth Wonnacott*

12:30 - 12:50 (S-2.4.) The development of the relationship between distributional learning and prediction in language. *Zhenghan Qi, Heesu Yun, Yi-Lun Weng & Amanda Owen Van Horne*

12:50 - 13:10 (S-2.5.) The Role of Chunking in Implicit Statistical Learning of Naturalistic Language: A Comparative Study on Indian Children With and Without Developmental Language Disorder and Developmental Dyslexia. *Arpitha Vasudevamurthy & Xiuli Tong*

CONFERENCE PROGRAM – THURSDAY, JUNE 11th

13:10 - 15:00 Break (Lunch on your own)

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15:30 - 15:50 (S-3.2.) Using speaker identity information to focus cross-situational learning of novel words. *Padraic Monaghan, Kin Chung Jacky Chan, Emily Mallinson, Katy Malcolm & Nomi Olsthoorn*

15:50 – 16:10 (S-3.3.) Using Eye Tracking to Investigate How Feedback is Integrated During Real-Time Statistical Learning. *Felicity F. Frinsel, Fabio Trecca & Morten H. Christiansen*

16:10 - 16:30 (S-3.4.) Understanding singular they becomes easier with exposure. *Jennifer E. Arnold, Yining Ye, Annika Herlant & James Kesan*

16:30 - 16:50 Poster Blitz II

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Neural Evidence for Rapid Statistical Learning from Natural Speech in an Unfamiliar Language. *Qifei Wang, Eva Berlot, Judit Fazekas, Jakub Szewczyk & Floris de Lange*

Follow the Dot: A New Scalable Mouse-Tracking Method for Studying Sequence Learning in Real Time. *Robyn Griffiths, Francesco Cabiddu, Mark Torrance, Gary Jones, Jens Roeser & Sofia Tsitsopoulou*

Exploration-Exploitation Strategy in Visual Statistical Learning: an EEG Study. *Qing Guo & Shelley Xiuli Tong*

How does the statistical learning timeline change when sequences are different frequencies or when pauses are inserted into the stream? *Gary Jones, Robyn Griffiths, Francesco Cabiddu, Jens Roeser, Sofia Tsitsopoulou & Mark Torrance*

When Predictions Falter but Movements Don't: Implicit Statistical Learning in Parkinson's Disease. *Maura Panozzo Chiomento, Maria Vender & Denis Delfitto*

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09:50 - 10:50 **Oral session 4: SL and cognitive abilities II**

09:50 - 10:10 (OS-4.1.) Distinct statistical learning mechanisms support the acquisition of adjacent and nonadjacent dependencies. *Laura Batterink, Daisy Li & Daniela Herrera-Chaves*

10:10 - 10:30 (OS-4.2.) The role of attention in (statistical) learning differs across development. *Amy Finn, Elena Greatti, Levi Antle & Davide Crepaldi*

10:30 - 10:50 (OS-4.3.) How experience shapes attention: Divergent neural signatures of Statistical and Reward Learning. *Carola Dolci, Tom Verguts, Elisa Santandrea & C. Nico Boehler*

10:50 - 11:10 **Poster Blitz III**

A unified mechanism of statistical learning? Evidence from cross-modal integration during learning. *Giulio Severijnen, Linda Drijvers & Davide Crepaldi*

Investigating brain markers of visual statistical learning in school-aged children using magnetoencephalography frequency-tagged responses. *Lauréline Fourdin, Vincent Wens, Oriane Van Dijck, Chiara Capparini, Xavier De Tiège & Julie Bertels*

MEG and EEG evidence for statistical learning from acoustic and abstract rhythms. *Lorenzo Titone & Lars Meyer*

Learning What Matters: Readers Adapt to Reliable Sources of Information to Resolve Print-Speech Uncertainty in an Opaque Writing System. *Naama Schwartz, Ram Frost & Noam Siegelman*

Language Experience Modulates the Statistical Learning of Speech With and Without Lexical Cues. *Kristina Backer, Sejin L. Niehorster-Cook, Sven L. Mattys & Heather Bortfeld*

What Statistical Learning Does and Doesn't Learn. *Mine Muezzinoglu, Rochelle S. Newman & L. Robert Slevc*

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15:00 – 15:20 (S-4.2.) Chunking is necessary, but not sufficient, to explain the time-course of statistical learning across sequence length, context, embedding, and position. *Francesco Cabiddu, Mark Torrance, Robyn Griffiths, Jens Roeser, Sofia Tsitsopoulou & Gary Jones*

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16:00 - 16:30 Coffee break

16:30 - 17:20 Early career talk Noam Siegelman. What I Have Learned About Statistical Learning (from Not Studying Statistical Learning)

17:20 - 18:00 Closing remarks & Round table

For Conference Dinner Attendees Only:

20:00 – 20:20 Bus transfer San Sebastian – Conference Dinner

20:30 – 23:20 CONFERENCE DINNER

23:30 – 23:50 Bus transfer to San Sebastian

CONFERENCE PROGRAM - POSTER SESSION I

16:20 – 18:00 Wednesday, June 10th

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PS.1.2. Absence of sex differences in implicit statistical learning. *Inés Botía, Bianka Brezóczki, Adrienn Holczer, Dezső Németh & Teodóra Vékony*

PS.1.3. Beyond the Single Stream: Neural Entrainment to Two Artificial Languages in Bilinguals and Monolinguals. *Konstantina Zacharaki, Bianca Franzoia & Ruth de Diego-Balaguer*

PS.1.4. Brain-like Representations in Predictive Coding Networks during Statistical Learning. *Denise Kittelmann, Dirk Gütlin & Ryszard Auksztulewicz*

PS.1.5. Children Use Distributional Morphosyntactic Cues to Infer Speaker Group Membership. *Yiran Chen, Lynna Tran & Jenny Saffran*

PS.1.6. Decoding Patterns: EEG Insights into Auditory Statistical Learning in Norwegian Children. *Giulia Zantonello, Fatih Sivridag, Valentin Vulchanov & Mila Dimitrova Vulchanova*

PS.1.7. Developmental trajectories of neural tracking of lexical-semantic features in children with cochlear implants. *Francesca Collesei, Jose Pérez-Navarro, Francesca Schiavone, Alessandra Federici, Marta Fantoni, Elena Nava, Eva Orzan, Benedetta Bianchi, Nicola Molinaro & Davide Bottari*

PS.1.8. Dimensional reweighting in sound category learning. *Yeojin Jung, Nadia Clement, Carina Ahrens, Kaori Idemaru & Vsevolod Kapatsinski*

PS.1.9. Dynamic Transition Networks of Dyadic Toy Play. *Noah Reardon, Julia Yurkovic-Harding, Dan Kennedy, Chen Yu & Linda Smith*

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CONFERENCE PROGRAM - POSTER SESSION I

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PS.1.15. Foreign Language Effect: A Triptych Framework. *Michelle Lai, Angela Tzeng & Shaun Chen*

PS.1.16. From co-occurrence to structure: seamless integration of space, time, and context in visual statistical learning. *József Fiser & Dominik Garber*

PS.1.17. How underlying statistical structures modulate the neural response to rapid auditory sequences. *Alice Milne, Buse Adams & Maria Chait*

PS.1.18. Inhibitory rTMS over the bilateral DLPFC modulates interference between competing statistical representations. *Emanuele Galladini, Andreas Alexandersen, Emanuele Ciardo, Felipe Pedraza, Teodóra Vékony & Dezső Németh*

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PS.1.21. Learning pairs without awareness - differentiating symbolic from statistical learning. *Claire Njoo-Deplante, Barbu Revencu & Ghislaine Dehaene-Lambertz*

PS.1.22. Learning under ambiguity: structured training and working memory in cross-situational word learning. *Yuxin Ge & Susana Correia*

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CONFERENCE PROGRAM - POSTER SESSION I

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PS.1.25. Performance Sensitivity to Increased Complexity reduces Learning Effects on Rhythms' Self-reported Liking. *Marc Deosdad-Díez & Josep Marco-Pallarés*

PS.1.26. Presenting "Mega-SL": A Large-Scale, Open Dataset for Statistical Learning Research. *Natan Ilani Shames, Nadav Weisler & Noam Siegelman*

PS.1.27. Referential adaptation in the face of changing input frequencies: The system wants to return to baseline. *James Kesan & Jennifer Arnold*

PS.1.28. Sensitivity to Informative Print-to-Sound and Print-to-Meaning Regularities Predicts Reading Skill and Growth in Reading Disability. *Ana Bobrycki, Daniel Kleinman, Dasha Zdvizhkova, Noam Siegelman, Jay Rueckl & Nicole Landi*

PS.1.29. Speaker variability and task order effects in cross-situational statistical learning. *Yuxin Ge, Xiaopeng Sun, Susana Correia, Gabriela Tavares & Patrick Rebuschat*

PS.1.30. Statistical language learning in adults: the role of individual differences in everyday executive functioning. *Evgenia Karantinou, Soila Kuuluvainen, Eleonore Smalle & Riikka Möttönen*

PS.1.31. Statistical Learning Development Across Infancy and Caregiver Influence: An Optically Pumped Magnetometer Magnetoencephalography (OPM-MEG) Study Design and Pilot Results. *Ailan Andrea Maria Kalledat, Robert Oostenveld, Sabine Hunnius & Marlene Meyer*

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PS.1.33. Statistical Learning of multi-lingual conceptual structures. *Chuqiao Song & Alejandro Tabas*

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CONFERENCE PROGRAM - POSTER SESSION I

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PS1.36. Strategic Flexibility in Orthographic Mapping: How Task Context Modulates Radical Sensitivity. *Denise Hsien Wu, Erin Isbilen, Yi-Syuan Huang & Andhika Renaldi*

PS.1.37. The effects of type and token frequency on semantic extension. *Zachary Houghton, Zara Harmon & Vsevolod Kapatsinski*

PS.1.38. The Impacts of Impact: Head Trauma's Relationship to Statistical Learning. *Kate Constan, Juliana Marques de Souza & Morten H. Christiansen*

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PS.2.3. Bilingual Artificial Grammar Learning: The Role of Indexical Cues in the Simultaneous Acquisition of Multiple Rule Structures. *Aaron Mitchel & Kyla Kelly*

PS.2.4. Can children learn nouns and verbs simultaneously from cross-situational statistics?. *Evie Adams, Simya Aravamuthan, Patrick Rebuschat & Padraic Monaghan*

PS.2.5. Children's sensitivity to natural language statistics predicts expressive and receptive language skills. *Brynn Siles, Anqi Hu, Anna Ciriello, Amanda Owen Van Horne, Morten Christiansen & Zhenghan Qi*

PS.2.6. Critical periods cannot wait: visually driven phonetic encoding in the absence of hearing. *Alessandra Federici, Marta Fantoni, Chiara Battaglini, Francesca Collesei, Giacomo Handjaras, Eva Orzan, Benedetta Bianchi, Giovanni M. Di Liberto & Davide Bottari*

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PS.2.8. Dissociable dynamic effects of expectation during statistical learning across cortical layers. *Hannah McDermott, Mahdi Enan, Federico De Martino & Ryszard Auksztulewicz*

PS.2.9. Does the left articulatory-motor cortex contribute to statistical language learning? A rTMS-EEG study. *Soila Kuuluvainen, Kajo Juopperi, Tatsuya Daikoku & Riikka Möttönen*

PS.2.10. Double Trouble: The Learning of Multiple Mappings in the Context of Cross Situational Word Learning. *Felicity F. Frinsel, Emily McArdle & Faline H. Yang*

PS.2.11. Element duration biases statistical chunking across vision and audition. *Linda Garami, Jia Hao Shan & József Fiser*

CONFERENCE PROGRAM - POSTER SESSION II

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PS.2.13. Follow the Dot: A New Scalable Mouse-Tracking Method for Studying Sequence Learning in Real Time. *Robyn Griffiths, Francesco Cabiddu, Mark Torrance, Gary Jones, Jens Roeser & Sofia Tsitsopoulou*

PS.2.14. How Affix Order Affects Learning in Ambiguous Contexts. *Holly Jenkins, Jinyu Shi, Michael Ramscar & Elizabeth Wonnacott*

PS.2.15. How does the statistical learning timeline change when sequences are different frequencies or when pauses are inserted into the stream?. *Gary Jones, Robyn Griffiths, Francesco Cabiddu, Jens Roeser, Sofia Tsitsopoulou & Mark Torrance*

PS.2.16. Implicit Statistical Learning Through the Serial Reaction Time (SRT) Task: A Case of Multiple Regularities in the Sequence. *Arpitha Vasudevamurthy & Xiuli Tong*

PS.2.17. Individual Differences in Readers' Sensitivity to Multiword Frequency in Naturalistic Settings. *Dan Steinhof, Erez Milshten, Inbal Arnon & Noam Siegelman*

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PS.2.20. Linguistic statistical regularities affect infants' lexical processing commitment. *Yiran Chen & Jenny Saffran*

PS.2.21. Modality Effects in Word Segmentation: Group-Level Similarities and Individual Differences. *Rebeca Garrido & Ángel Eugenio Tovar*

PS.2.22. Neural entrainment reflects attention-dependent tracking of visual statistical structure. *Elena Greatti, Laura Batterink, Davide Crepaldi & Amy Finn*

PS.2.23. Neural Evidence for Rapid Statistical Learning from Natural Speech in an Unfamiliar Language. *Qifei Wang, Eva Berlot, Judit Fazekas, Jakub Szewczyk & Floris de Lange*

CONFERENCE PROGRAM - POSTER SESSION II

16:50 – 18:30 Thursday, June 11th

PS.2.24. Obsessive-Compulsive Tendencies Modulate the Balance Between Statistical Learning and Cognitive Flexibility. *Bianka Brezóczki, Teodóra Vékony, Bence Csaba Farkas, Flóra Hann & Dezső Németh*

PS.2.25. Online Hierarchical Network Dynamics Underlying Beat-Informed Non-Adjacent Dependency Learning. *Alba Nuez-Vilà, Tomas Berjaga-Buisan, Gustavo Deco, Estela Camara-Mancha & Ruth de Diego-Balaguer*

PS.2.26. Predictability in Production: Mandarin Classifier-Noun Selection and Optional Modification. *Jinyu Shi, Kate Nation & Elizabeth Wonnacott*

PS.2.27. Prediction error in the processing of non-binary pronouns: is novelty more costly than redistribution?. *Mara Guimarães & Ari Azevedo*

PS.2.28. Rethinking forced-choice paradigms: Statistically induced chunking recall (SICR) as an assessment of statistical learning in autism. *Rebecca R. Bell & Inge-Marie Eigsti*

PS.2.29. SemV: Words as Volumes in Semantic Space. *Kevin Brown, Kyle Free, Jonathan Mitchell, Sasha Kenjeeva, Jay Rueckl & Davide Crepaldi*

PS.2.30. Sensitivity to Word Predictability in Naturalistic Reading: Individual Differences and Adaptive Tuning. *Erez Milsthen, Yoel Sheinenson, Nameer Najajra & Noam Siegelman*

PS.2.31. Similar errors, different updating: a mechanistic account of developmental differences in statistical learning. *Orsolya Pesthy, Eszter Tóth-Fáber, Cintia Anna Nagy, Karolina Janacsek & Dezső Németh*

PS.2.32. Speakers respond differently to statistical uncertainty about signals vs. messages. *Amalia Spyromilio, Holly Jenkins, Elizabeth Wonnacott & Michael Ramscar*

PS.2.33. Statistical Learning and Word Segmentation in Norwegian Infants: No Evidence Across Dialectal Variability. *Ana Boskovic, Audun Rosslund, Julien Mayor & Natalia Kartushina*

PS.2.34. Statistical learning defines which discourse biases guide pronoun interpretation. *Jennifer E. Arnold, Yining Ye, Simantika Roy & James Kesan*

CONFERENCE PROGRAM - POSTER SESSION II

16:50 – 18:30 Thursday, June 11th

PS.2.35. Statistical Learning of Grammar and Semantics in Adult L2 Acquisition: Evidence from Mandarin Classifier–Noun Combinations. *Zhengyuan Yang, Elizabeth Wonnacott, Faidra Faitaki & Holly Jenkins*

PS.2.36. Statistical learning of phonotactic probabilities through passive listening of a second language in adults. *Rae Hoeppner, Amiya Aggarwal & Laura Batterink*

PS.2.37. Statistical learning of syllable sequences and responses to violations: a joint MMN–ITPC EEG approach. *Fatih Sivridag, Maren Cremer, Caspar Schwiedrzik & Nivedita Mani*

PS.2.38. The Association between Childhood Adversity and Statistical Learning Ability in Children: A Neuroimaging Study. *Leyla Eghbalzad, Vishwadeep Ahluwalia, Zhenghan Qi & Christopher Conway*

PS.2.39. The cortical dynamics of 'statistical hearing'. *Isma Zulfiqar, David Haydock, Adam Tierney, Lori L Holt & Fred Dick*

PS.2.40. The interference of congruent and incongruent multimodal stimuli in statistical learning. *Szabolcs Sáringer, Hedvig Sütő, Regina Gerencsér, András Benyhe & Péter Kaposvári*

PS.2.41. The Pace of Change: How the Schedule of Learning Conflicting Regularities Shapes Their Organization in Memory. *Amir Tal & Lila Davachi*

PS.2.42. Toddlers' grammatical knowledge influences predictive language processing. *Elise Breitfeld & Jenny Saffran*

PS.2.43. Unlocking the Secrets of Multilingualism: How Individual Differences in Implicit Statistical Learning Associate with Metalinguistic Skills and Reading in Indian Multilingual Children. *Arpitha Vasudevamurthy & Xiuli Tong*

PS.2.44. When Predictions Falter but Movements Don't: Implicit Statistical Learning in Parkinson's Disease. *Maura Panozzo Chiomento, Maria Vender & Denis Delfitto*

CONFERENCE PROGRAM - POSTER SESSION III

11:10 – 13:00 Friday, June 12th

PS.3.1. A unified mechanism of statistical learning? Evidence from cross-modal integration during learning. *Giulio Severijnen, Linda Drijvers & Davide Crepaldi*

PS.3.2. Assessing neural signatures of statistical learning: A meta-analysis of EEG/MEG studies. *Isabella Toselli Prequero, Liesa Ravijts, Brent Vernaillen, Rodrigo Dal Ben, Débora de Hollanda Souza & Louisa Bogaerts*

PS.3.3. Benchmarking Long-Distance Statistical Learning in Simple Recurrent Networks. *Jacy To, Alejandro Tabas & James S. Magnuson*

PS.3.4. Beyond Word Familiarity: The Semantic Network Anchors Word Learning from Co-occurrence in Childhood. *Olivera Savic, Layla Unger & Vladimir Sloutsky*

PS.3.5. Capturing learning on the fly: an eye-tracking method to quantify prediction errors and updating the prior. *Flóra Hann, Cintia Anna Nagy, Zita Olivia Nagy, Dezső Németh & Orsolya Pesthy*

PS.3.6. Categorical or scalar? Error-driven learning as a window on the nature of phonetic representations. *Zachary Houghton, Emily Morgan & Vsevolod Kapatsinski*

PS.3.7. Dialogic reading enhances neural prediction of young children. *Shinmin Wang, Chia-Feng Lu & Ovid J.L. Tzeng*

PS.3.8. Distinct Neural Representations of Probability for Abstract and Item-Specific Information During Statistical Learning. *Mei Zhou & Shelley Xiuli Tong*

PS.3.9. Does Domain-General Statistical Learning Predict Perceptual Learning for Non-Canonical Speech?. *Katerina Tetzloff & Stephanie Borrie*

PS.3.10. Early response time Variability predicts Statistical Learning. *Emanuele Ciardo, Andreas Alexandersen, Emanuele Galladini, Teodóra Vékony & Dezső Németh*

PS.3.11. EEG frequency tagging reveals preserved statistical learning in preterm children aged 4–6 years. *Liesa Ravijts, Jorn Othmer, Petra Warreyn & Louisa Bogaerts*

PS.3.12. Friends or Foes? The Interplay Between Statistical Learning and Executive Functions. *Eszter Tóth-Fáber, Bence C. Farkas, Anna Boglárka Kocsis, Orsolya Pesthy, Bianka Brezóczki, Andrea Kóbor, Karolina Janacsek & Dezső Németh*

PS.3.13. Harnessing implicit statistical knowledge to optimize reward-based decisions. *Andrea Kóbor, Anna Boglárka Kocsis & Zoltán Vidnyánszky*

CONFERENCE PROGRAM - POSTER SESSION III

11:10 – 13:00 Friday, June 12th

PS.3.14. Individual Differences in Adaptation and Error Minimization During Statistical Learning: A Webcam-Based Eye-Tracking Study. *Puyuan Zhang, Shelley Tong & Erin Ottmar*

PS.3.15. Individual Differences in Reading Comprehension are Related to Sensitivity to Predictability Effects During Connected Text Reading. *Kelly Mahaffy, Luca Campanelli, Daniel Kleinman & Nicole Landi*

PS.3.16. Investigating brain markers of visual statistical learning in school-aged children using magnetoencephalography frequency-tagged responses. *Lauréline Fourdin, Vincent Wens, Oriane Van Dijck, Chiara Capparini, Xavier De Tiège & Julie Bertels*

PS.3.17. Language Experience Modulates the Statistical Learning of Speech With and Without Lexical Cues. *Kristina Backer, Sejin L. Niehorster-Cook, Sven L. Mattys & Heather Bortfeld*

PS.3.18. Learning What Matters: Readers Adapt to Reliable Sources of Information to Resolve Print-Speech Uncertainty in an Opaque Writing System. *Naama Schwartz, Ram Frost & Noam Siegelman*

PS.3.19. MEG and EEG evidence for statistical learning from acoustic and abstract rhythms. *Lorenzo Titone & Lars Meyer*

PS.3.20. Multilingualism and Statistical Learning. *Josephine Glenn & Sharon Peperkamp*

PS.3.21. Near-optimal auditory but suboptimal visual detection of temporal regularities. *Hamit Basgol, Peter Dayan & Volker H. Franz*

PS.3.22. Readers' Sensitivity to Word-Length Combinations in Hebrew and English. *Golan Ankory Shaked, Juliana Marques de Souza, Avital Deutsch, Morten H. Christiansen & Ram Frost*

PS.3.23. Revisiting Statistical Learning in Transformer-Based Models. *Izei Múgica, Linkai Peng & James S. Magnuson*

PS.3.24. Rich Reader Phenotypes of Sensitivity to Language Statistics Explain Individual Differences and Tradeoffs in Reading. *Tal Koren & Noam Siegelman*

PS.3.25. Same Sentences, Different Senses: How Input Modality Shapes Comprehension. *Felicity F. Frinsel, Faline H. Yang & Emily McArdle*

CONFERENCE PROGRAM - POSTER SESSION III

11:10 – 13:00 Friday, June 12th

PS.3.26. Segmentation of an artificial language with conflicting statistical cues: Empirical and computational investigations. *Chiara Bernini, Marina Kalashnikova & James S. Magnuson*

PS.3.27. Statistical Learning Across the Lifespan: Dissociations between neural and behavioural markers. *Claudia Ruzza & Davide Crepaldi*

PS.3.28. Statistical learning and abstract knowledge transfer in structured environments. *Beáta Tünde Szabó & József Fiser*

PS.3.29. Statistical learning and short-term memory of manual gestures: Evidence for stimulus-general and stimulus-specific processes. *Yi-Syuan Huang, Karen Emmorey, Ovid J. L. Tzeng & Denise Hsien Wu*

PS.3.30. Statistical learning in language across multiple regularities: a micro-longitudinal study. *Isabelle O'Halloran & Jelena Mirković*

PS.3.31. Structure transfers, rules do not: Evidence from statistical learning across stimulus-response mappings. *Cintia Anna Nagy, Orsolya Pesthy, Teodóra Vékony, Flóra Hann, Eszter Tóth-Fáber, Bianka Brezóczki & Dezső Németh*

PS.3.32. Swap distance minimization shapes the order of subject, object and verb in languages of the world. *Jairo El-Jazidi-Rios & Ramon Ferrer-i-Cancho*

PS.3.33. Tactile cues aligned with high-level linguistic features shape neural processing of speech in noise. *Erica Iob, Alessandra Federici, Francesca Schiavone, Francesca Collesei & Davide Bottari*

PS.3.34. The Alien Language Game: Investigating Modality Constraints on Statistical Learning in School-Aged Children. *Gwen Radecki, Haley Kragness & Aaron Mitchel*

PS.3.35. The Blueprint of Semantics: Zipf's Laws of Meaning and the Evolution of Semanticity in Catalan Language Acquisition. *Maria Tubella Salinas, Neus Català Roig & Antoni Hernández-Fernández*

PS.3.36. The distributional statistics of acoustic and perceptual auditory dimensions affect sound detection. *Isma Zulfiqar, Alain de Cheveigné, Adam Tierney, Lori L Holt & Fred Dick*

CONFERENCE PROGRAM - POSTER SESSION III

11:10 – 13:00 Friday, June 12th

PS.3.37. The Language of Mathematics: Can Statistical Learning also Predict Mathematical Development?. *Maurice De Walsche, Cathy Hauspie, Michelle Janssens, Christophe Vanhouwe, Wouter Duyck & Arnaud Szmalec*

PS.3.38. The role of feature predictability in modulating toddlers' word extension strategies. *Elise Breitfeld & Jenny Saffran*

PS.3.39. The Role of Perceptual Salience in Cross-Situational Learning. *Sara Fernández Santos, Patrick Rebuschat, Susana Correia, Padraic Monaghan & Miquel Llompart*

PS.3.40. Tracking Patterns Across Languages: Statistical Learning in Bilingual Babbling. *Lexi Ricasata, Graciela Knudsen, Gabriel Cler & Amy Pace*

PS.3.41. Unraveling the impact of ADHD-like traits on the interplay between predictive processes and inhibitory control. Karolina *Horváth, Bianka Brezóczki, Adrienn Holczer, Teodóra Vékony & Dezső Németh*

PS.3.42. What Statistical Learning Does and Doesn't Learn. *Mine Muezzinoglu, Rochelle S. Newman & L. Robert Slevc*

ABSTRACTS

[K-1]

Beyond GOLABUPABIKU

Jenny Saffran [1]

[1] University of Wisconsin-Madison

In the three decades since Saffran, Aslin, & Newport published their initial papers on statistical language learning, our field has

focused on questions that we could not even have imagined back in 1996. In my presentation, I will discuss some of the ways the field has grown and developed over the past 30 years, with a particular focus on infant language learning.

[K-2]

Curiosity in human statistical learning: computational theories, experiments and applications in AI and education

Pierre-Yves Oudeyer [1]

[1] Inria Center of University of Bordeaux,

A remarkable feat of children's development is their autonomy, open-endedness, flexibility and efficiency at learning world models and diverse skills, collecting their own statistical learning data under strongly limited resources of time and energy. In this talk, I will explain why and how curiosity mechanisms play a crucial role in such capabilities, using a mix of computational theory, AI models, and behavioural experiments to test predictions of these theories.

I will discuss in particular three theoretical perspectives:

1) the Learning Progress theory, proposing that humans use statistical measures of their own learning progress to decide what to explore next; I discuss the links between this theory and metacognition, and I will explain how the theory accounts for long term self-organization of developmental structures in human children, as well as for the statistical properties of human developmental trajectories; I also explain how some of its predictions were confirmed in recent experimental paradigms with diverse populations, and in experiments run in various labs in the world;

2) Autotelic curiosity-driven exploration, whereby individuals invent, select and pursue their own goals, a very important form of curiosity at the roots of human curiosity and open-ended development, which also forms the basis of recent advances in building open-ended autotelic statistical learning systems;

3) Language as a cognitive tool to boost creative curiosity-driven autotelic exploration.

Beyond providing insights on human development, I also show how this sets the ground for new forms of open-ended AI systems, including autotelic robots exploring and learning in real time in complex environments. Finally, I show several projects and experimental results in classrooms transposing these insights in educational interventions aimed to foster and train curiosity in children, e.g. using structured statistical learning methods that leverage the learning progress hypothesis for adaptive personalization of learning curricula in educational technologies.

[K-3]

The Development of the Experience-Expectant Mind

Nora S. Newcombe [1]

[1] Temple University

The core challenge in the study of cognitive development is to specify what infants bring to the task of learning, and how inborn biological processes interact with environmental input to propel change, often extending through childhood and adolescence. Ideally, we would delineate not only the typical developmental trajectory for important lines of development, but also the drivers of that trajectory, and how variation in those drivers leads to variation across children, families, communities, and cultures, and differences among adults in their patterns of skills. One of the chief challenges to achieving these goals is the difficulty of specifying relevant environmental input, especially in domains other than language. In this talk, I will consider progress so far in the domains of small- and large-scale spatial thinking.

EARLY CAREER TALK

What I Have Learned About Statistical Learning (from Not Studying Statistical Learning)

Noam Siegelman [1]

[1] Hebrew University of Jerusalem

In recent years, the study of reading has become increasingly grounded in theories of statistical learning, with a growing number of scholars viewing reading acquisition as "an exercise in statistical learning." This perspective has generated important insights into the nature of reading and the sources of individual differences in reading. In this talk, I will focus on the opposite direction of the statistical learning–reading relation, demonstrating how studying reading constitutes an ecological experiment that can constrain and refine theories of statistical learning more broadly. Specifically, drawing on recent studies of naturalistic reading behavior measured through eye movements, I will show that (1) real-world inputs encompass rich, quasi-regular statistical structures; (2) statistical learning computations, and the behaviors they give rise to, are more complex and nuanced than previously documented; and (3) individual differences are tied to the efficient navigation of competing sources of information. I will conclude by discussing the benefits of studying statistical learning not only through controlled paradigms, but also through the analysis of ecological behaviors.

[S-1]

Evolution and Cross-Species Perspectives on SL. Theme Speaker: **Inbal Arnon**

[S-1.1]

Cultural evolution creates language-like structure: from humans to humpback whales and beyond

Inbal Arnon [1]

[1] Hebrew University

While the world's languages differ in many respects, they share certain commonalities: these can provide crucial insight into our shared cognition and how it impacts language structure. In this talk, I focus on two statistical properties of language: All known languages are made up of statistically coherent sequences - words - whose frequency distribution follows a power law known as a Zipfian distribution. Despite the ubiquity of these features across languages their origins are poorly understood. Here, I propose both properties confer a learnability advantage, making them good candidates for arising through cultural transmission. In the first part, I will present a set of results on the learnability sources and consequences of such distributions in human language, looking at infants, children, and adults. I will then present results from an iterated learning study in which non-linguistic sequences evolve to have both properties as they are transmitted across multiple generations of participants. Using insights from infant speech segmentation, we develop analytic pipelines for analyzing the sequences, and observe the emergence of Zipfian distribution over generations. If cultural transmission drives the emergence of such distributions, we may find them in other culturally transmitted communication systems in nature. Together with Simon Kirby and Ellen Garland, we test this prediction by looking at the culturally evolving song of humpback whales. We apply our infant-inspired pipeline to 8 years of whale recordings, and show, for the first time in another species, that these characteristic statistical properties are indeed present in whale song. This demonstrates a deep commonality between two very different species united by having culturally transmitted communication. Throughout the talk I will highlight open questions at the intersection of developmental psychology, language evolution, and comparative cognition, and point to ways in which cross-species and cross-method collaborations can promote our understanding of the origin of complex communication.

[S-1.2]

Dog puppies, pigs, and wild boars do not track complex statistical patterns in speech as adult dogs do

Attila Andics [1 2], Kinga G.Tóth [1 3 4], Kitti Szabó [1] & Marianna Boros [1]

[1] Neuroethology of Communication Lab, Department of Ethology, Eötvös Loránd University; Budapest, Hungary

[2] ELTE NAP Canine Brain Research Group; Budapest, Hungary

[3] Doctoral School of Biology, Institute of Biology, ELTE Eötvös Loránd University; Budapest, Hungary

[4] Cooperative Doctoral Program 2023, National Research, Development and Innovation Office, The Ministry of Culture and Innovation; Budapest, Hungary

Human-analogue transitional probability (TP) computations for speech segmentation have recently been demonstrated in adult dogs. However, the origin of this ability remains unclear: it may be a general mammalian capacity, or instead result from domestication or experience with speech. To address this question, we tested statistical learning from speech in three populations, adult companion pigs (Sus scrofa domesticus, N=8), hand-raised 4-month-old wild boars (Sus scrofa, N=5), and shelter-raised 4-month-old dogs (N=11), using the same speech segmentation paradigm previously applied in adult dogs. Non-invasive EEG was used to record event-related potentials (ERPs) to trisyllabic artificial words with different statistical properties previously presented as part of a continuous speech stream. All three groups segmented the speech stream based on co-occurrence frequencies, but none of the groups showed evidence of the more complex TP-based computations. On the one hand, these results suggest that tracking co-occurrence frequencies is a conserved mammalian ability that can support speech segmentation without domestication or prior exposure to speech. On the other hand, these findings also indicate that for the emergence of the ability to track TPs in speech, both a special selection for communication during domestication and prior exposure to speech may be necessary.

[S-1.3]

Recursive Statistical Learning in Adults, Children, and Monkeys

Elijah Tramm [1] & Stephen Ferrigno [1]

[1] University of Wisconsin-Madison

Learning often occurs at multiple levels of analysis. For example, to detect regularities among words, infants must first detect regularities among syllables to chunk them into words (Saffran & Wilson, 2003). An important question is how statistical learning mechanisms interact (Romberg & Saffran, 2010). One possibility is that outputs are recursively used as inputs.

We tested whether adults, children (3-7), and rhesus monkeys could perform recursive statistical learning (RSL) by re-applying statistical learning to its own output, allowing them to discover regularities at new levels. Using Schmid et al.'s (2023) binary serial reaction time paradigm, we investigated whether participants were sensitive to regularities at multiple levels. In this task, recursively applying statistical learning can reveal previously probabilistic transitions as deterministic. By measuring reaction time, we can determine whether participants are sensitive to these probabilities.

We found that adults reacted faster to deterministic transitions revealed by three applications of RSL. In contrast, children reacted faster only to transitions revealed by basic statistical learning. Monkeys reacted faster to deterministic transitions revealed by one application of RSL. We discuss the implications of these results for the evolutionary and developmental origins of complex sequence learning and the role of statistical learning therein.

[S-1.4]

Disentangling implicit from explicit sequence learning in primates

Raphaelle Malassis [1 2], Laura Moscado [1], Jerome Sackur [1 3] & Dezső Németh [2 4]

[1] Laboratory of Cognitive Science and Psycholinguistics (CNRS / ENS-PSL) Paris, France

[2] Centre de Recherche en Neurosciences de Lyon (INSERM / CNRS / Université Claude Bernard Lyon 1) Bron, France

[3] Ecole des Hautes Etudes en Sciences Sociales (EHESS) Paris, France

[4] BML-NAP Research Group, Institute of Psychology, Eötvös Loránd University & Institute of Cognitive Neuroscience and Psychology, Research Centre for Natural Sciences, Budapest, Hungary

Sequential regularities can be learned implicitly or explicitly by humans. Whether a similar dual-route to sequence learning exists in other primate species remains unknown. One reason is methodological: it requires designing tasks that rely neither on verbal instructions nor verbal reports. In this talk, we will introduce a nonverbal version of a gold-standard test for probing implicit and explicit sequence knowledge: the Process Dissociation Procedure (PDP). After a phase of exposure to sequential regularities, participants' control over sequence reproduction -a hallmark of explicit learning- was probed by contrasting two conditions: one where they must reproduce the same sequences, and the other where they must avoid doing so. Departing from conventional design, participants had to discover the task rules through trial and error. Data from 32 human adults showed that only participants who could report both the sequences and the task rules achieved ceiling-level performance on the PDP task, suggesting that this task is well-suited to disentangle implicit and explicit learning in nonverbal populations. We will conclude by presenting preliminary data obtained from that task in three non-human primate species and by discussing the scope and limits of this comparative approach.

[S-2]

Computation and Language. Theme Speaker: **Marc Joanisse**

[S-2.1]

Statistical language learning in a quasi-regular world

Marc Joanisse [1]

[1] The University of Western Ontario

The statistical learning framework proposes that the rules of language are learnable by capturing and amplifying subtle probabilistic cues in the input. This would appear to be a natural fit with emerging "NeuroAI" work seeking to align neurocognitive data with the inner workings of artificial neural networks (ANN) such as large language models. In this talk I take a step back and discuss ways in which even relatively simple ANNs can capture language patterns by exploiting and amplifying its statistical nature. An interesting nuance in this story is that natural language is by its very nature quasi-regular; regular and lawful patterns are occasionally interspersed with exceptional cases. I argue these anomalous patterns are everywhere when you begin to look for them; but also, their nature requires computing statistics at multiple levels of granularity to fully characterize them. I discuss these ideas with respect to modelling work that captures graded effects in learning and representing quasi-regular phonological, morphological and lexical patterns. I also argue that this statistical/computational approach can shed light on such (arguably artificial) distinctions as rules vs. exceptions; monosemous and polysemous words; and monolingualism vs. bilingualism.

[S-2.2]

Deaf readers' sensitivity to orthographic statistics: Evidence from a word search task

Karen Emmorey [1], Enza Visco [2], Allison Bassett [1] & Erin Isbilen [3]

[1] San Diego State University

[2] Gallaudet University

[3] Yale University

Despite less robust phonological skills, some deaf individuals become skilled readers on par with their hearing peers. One avenue to reading success in this population may be a reliance on the statistical properties of written words. We investigated the sensitivity of adult deaf readers (n=45) to orthographic structure using a novel word search paradigm which measures the ability to chunk letters into words based on the statistics of written English (from Isbilen et al., 2025). We evaluated whether sensitivity to the statistical regularities of English text predicted measures of reading skill, and compared deaf individuals' performance to that of hearing individuals (equated for reading skill). Word search performance correlated with English vocabulary knowledge and spelling recognition, but not with orthographic awareness (in contrast to hearing readers). Deaf readers, like hearing readers, were more accurate at identifying high frequency words, but unlike hearing readers, were unaffected by semantic diversity. Deaf readers were more sensitive to bigram frequency and word length, performing better than hearing readers on words with higher bigram frequencies and on longer words. Thus, while statistical learning supports reading in both populations, deaf readers attend to different statistical regularities of text, suggesting multiple pathways to successful reading.

[S-2.3]

Developmental approach reveals the statistical learning pattern of neural language models: transformers generalize from the most global distributional patterns

Wang Bojun [1], Holly Jenkins [1] & Elizabeth Wonnacott [1]

[1] Department of Education, University of Oxford

Neural language models (NLM) like GPTs acquire language cognition by simply tracking the various statistical structures in the input corpora. Understanding their learning mechanism is essential for a descriptive theory on their representation of language. In this study, we propose a developmental approach to investigate the statistical learning of NLM. A series of Transformer models are trained by an artificial grammar. Model states are saved at multiple stages in the course of training. Through analyzing how the behaviour and neural representation of these models change in the developmental path, we found that over-generalizations are rampant in the path of NLM learning. They acquire the most global distributional patterns at the beginning of learning. The dependency schema acquired at this stage are highly over-productive. In the latter learning path, NLMs gradually constrain over-generalizations by acquiring more local statistical dependencies. This learning path contrasts with the way that humans build up the language cognition, which acquire the local grammatical structures earlier and form more abstract generalizations in the latter stage of learning.

[S-2.4]

The development of the relationship between distributional learning and prediction in language

Zhenghan Qi [1], Heesu Yun [1], Yi-Lun Weng [2] & Amanda Owen Van Horne [2]

[1] Northeastern University

[2] University of Delaware

Distributional learning enables language users to extract probabilistic relationships between verbs and syntactic structures from experience, and these learned distributions may in turn support real-time prediction during comprehension. We examined this reciprocal relationship in two verb-bias learning studies with ambiguous with-phrase sentences (e.g., hug the bunny with the bottle), one with children and one with adults. Across both studies, brief exposure to familiar verbs in instrument- or modifier-biased contexts shifted subsequent interpretations of ambiguous sentences, demonstrating rapid updating of verb-specific distributional knowledge. In children, newly learned verb biases influenced both offline interpretations and anticipatory eye movements, with older children showing greater changes in final interpretations and younger children showing greater growth in anticipatory looking. In adults, successful updating of verb bias was similarly associated with increased anticipatory looks to trained referents. Critically, in both age groups, larger mismatches between learners' initial verb biases and the trained structure predicted greater learning, consistent with error-based accounts in which deviations from expected distributions drive adaptation. Adults who showed stronger semantic prediction in a separate comprehension task also showed stronger learning-related predictive changes. Together, these findings indicate that distributional learning both supports and is shaped by predictive processing across development.

[S-2.5]

The Role of Chunking in Implicit Statistical Learning of Naturalistic Language: A Comparative Study on Indian Children With and Without Developmental Language Disorder and Developmental Dyslexia

Arpitha Vasudevamurthy [1] & Xiuli Tong [1]

[1] The University of Hong Kong

Mixed evidence of implicit statistical learning (ISL) in children with developmental language disorder (DLD) and developmental dyslexia (DD) may stem from task modality or domain-specific stimuli that fail to tap into actual language processors. This study examined ISL of multisyllabic regularities using naturalistic language stimuli from the Zipfian distribution of a children's Kannada print corpus. Fifty-six Indian children (28 typically developing, 28 with DLD+DD), aged 7–13 years, completed an auditory-visual Kannada statistically induced chunk recall (KAN-SICR) and 2-AFC measure. The correlation between bilingual metalinguistic skills and both ISL measures was examined.

Results showed a significant group difference emerged mutisyllabic KAN-SICR measure, but no significant group difference on the 2-AFC measure. The TD group significantly recalled target trigram SOC chunks more than foils, which were absent in the DLD+DD group. This linked the moderation of chunk length and verbal-working memory deficit in DLD+DD. Furthermore, metalinguistic skills correlated significantly with KAN-SICR performance but not with the 2-AFC measure. These results highlight the importance of process-based measures to identify language-specific deficits in DLD and DD. The results further suggest ISL operates as a cognitive faculty within a multi-component memory system, revealing the interplay between verbal short-term memory and ISL's chunking mechanisms.

[S-3]

SL and language. Theme Speaker**: Patrick Rebuschat**

[S-3.1]

Cross-Situational Learning as a Central Paradigm for Statistical Learning: Evidence from 20 Years of Research

Patrick Rebuschat [1]

[1] Lancaster University

Statistical learning plays a fundamental role in language, enabling learners to extract regularities from the distributional properties of sensory input. Yet language learning requires more than sensitivity to structure in form alone: to know a language is to determine how sounds, words, and grammatical structures map onto objects, actions, events, relations, and states in experience. Against this backdrop, I argue that cross-situational learning (CSL) provides a particularly informative paradigm for studying statistical learning in language because it directly targets this form–meaning mapping problem. Although CSL is now well established, it has received less attention than research on sequential dependencies in continuous input, despite addressing a central challenge for theories of language acquisition (Isbilen & Christiansen, 2022). Drawing on a recent meta-analysis (230 experiments, 18,210 participants), this talk shows that CSL yields robust learning overall (Hedges' g = 1.73), extends beyond noun learning to both vocabulary and grammar, and identifies the conditions under which learners most successfully map language to the world (Rebuschat, Ge, & Monaghan, under review). Taken together, the meta-analysis suggests that cross-situational learning should be treated not as a peripheral variant of statistical learning, but as a central paradigm for understanding how learners use distributional evidence to build meaningful representations of language.

[S-3.2]

Using speaker identity information to focus cross-situational learning of novel words

Padraic Monaghan 1, Kin Chung Jacky Chan 2, Emily Mallinson 3, Katy Malcolm 1 & Nomi Olsthoorn 1

[1] Lancaster University

[2] Durham University

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Learning new words in a bilingual environment is challenging, but learners may be sensitive not only to what is spoken but also by whom. We investigated how mixing words across languages in close proximity (local condition) affected learning compared to words spaced out in usage (global condition). In two cross-situational learning studies, we determined how adult participants used speaker cues acquire word-referent mappings that were from two languages (2-1 mappings) compared to one language (1-1).

We manipulated whether speaker identity was language-relevant. In Study 1, two speakers were male and female with UK accents. In Study 2, speakers had Estonian or UK accent.

2-1 mappings were harder to learn than 1-1 mappings, particularly in the local condition. For speaker identity, gender in Study 1 had no effect, but speaker accent influenced learning in Study 2: 2-1 mappings were acquired better from local than foreign accent but this had no effect on learning 1-1 mappings, and was general across local and global conditions. Language mixing is challenging, but identity of speakers according to their accent can be used by learners to focus learning from overlapping input in language mixing situations.

[S-3.3]

Using Eye Tracking to Investigate How Feedback is Integrated During Real-Time Statistical Learning

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Statistical learning has been implicated in many aspects of behavior and cognition, particularly within the study of language. While it is known that learners track distributional cues in vocabulary and syntax acquisition, most experiments use passive exposure followed by a test, leaving the time-course of learning unclear. Using eye tracking we examined how feedback affects online learning of language-like statistical regularities in an artificial language. English-speaking participants were presented auditorily with sequences of nonsense words that followed non-English dative patterns: prepositional-dative (e.g., the boy gives the flower to the girl) or double-object (e.g., the boy gives the girl the flower). For each sequence, participants were shown four images of three characters in different who-gave-what-to-whom scenes and instructed to click the picture matching the sentence. We found that prior to making a response, all four visual scenes were considered as equally plausible alternatives at first. However, as learning progressed, foils were rejected more quickly as plausible alternatives as learners became sensitive to the statistical pattern of the language. Moreover, gaze data showed vocabulary learning preceded acquisition of structural regularities. Our findings reveal not only what information learners used (e.g., syntactic, semantic, interactional), but also how its use evolved during learning.

[S-3.4]

Understanding singular they becomes easier with exposure.

Jennifer E. Arnold [1], Yining Ye [1], Annika Herlant [1] & James Kesan [1]

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The English pronominal system is in the midst of incorporating a new form of singular they. E.g., in "Will and Alex went to a restaurant. Will handed the salt to Alex. Then they ate pasta.," "they" could be singular (Alex) or plural (Alex-and-Will). In four experiments we test whether statistical learning changes the availability of singular vs. plural interpretations. Participants meet characters and learn their pronouns (e.g., Alex-they/them; Will-he). They hear stories while looking at pictures of characters and objects (Alex, Will, Alex-and-Will); they are told that each character interacts with the objects under their picture, and the participant's job is to click on the object mentioned, e.g. pasta. Test stories are ambiguous; e.g. pasta is under both Alex and Alex-and-Will. Participants' selection signals singular vs. plural interpretation. We manipulate recent exposure: multiple unambiguous stories use either singular or plural they. Results reveal more singular interpretations in singular vs. plural exposure conditions; reaction times are faster when exposure matches participants' selection. Statistical learning also generalizes to other characters (not just the primed character), and exposure to Alex-they also promotes singular interpretation with descriptions (The gardener…they). This demonstrates that statistical learning underlies an ongoing change to the English pronoun system.

[S-4]

SL and learning mechanisms. Theme Speaker: **Marco Marelli**

[S-4.1]

Subtle but systematic: Form-meaning mapping in the processing of unfamiliar words

Marco Marelli [1]

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We learn new words almost on a daily basis: as adults, a new element is introduced in our vocabulary every other day. However, when we experience, as adults, a new word, its referent is not typically immediately available in the same context. How then can we comprehend novel words, simply on the basis of an unfamiliar sequence of sounds or graphical elements? Reliable distributional associations between the form of a word and its meaning seems to be the main driving force behind such remarkable ability. Such systematicity is a prominent property of natural languages, and speakers are shown to largely exploit it via statistical learning. Moving from the tenets of distributional semantics, I will present a series of data-driven computational models that abandon a word-centred perspective, and capture meaning as the result of systematic patterns in sublexical information. The predictions of such approaches align with psycholinguistic results concerning the comprehension of novel words, both in terms of explicit intuition and implicit processing. This evidence indicate that semantic access largely relies on form-meaning mapping processes, going beyond arbitrary relations between well-defined symbols and meaning representations.

[S-4.2]

Chunking is necessary, but not sufficient, to explain the time-course of statistical learning across sequence length, context, embedding, and position

Francesco Cabiddu [1], Mark Torrance [1], Robyn Griffiths [1], Jens Roeser [1], Sofia Tsitsopoulou [1] & Gary Jones [1]

[1] Nottingham Trent University

Statistical learning is a fundamental learning mechanism, yet how it operates remains unclear. This is partly because most studies ignore time-course behaviour and test a narrow range of sequence lengths, limiting insight into the learning process. We propose a new mouse-tracking statistical learning paradigm that records time-course behaviour and trains participants on a broad range of sequence lengths. Across six pre-registered studies (each with N = 36) using uniform (2-, 3-, or 4-item) and mixed-length sequences (2+4, 3+4, 2+3), we found that shorter sequences were learned better than longer ones; sequences were learned better in shorter contexts (e.g., 4-item sequences in mixed vs uniform designs); sequences were learned better as standalone sequences than when embedded within larger sequences; and later items in a sequence were learned better than earlier ones. We tested these data against prominent transitional probability (SRN) and chunking (PARSER, TRACX) accounts. Chunking fit the human data better than transitional probability across all research questions, with PARSER fitting the data better than TRACX in most cases. Importantly, no model predicted all effects found in the data, highlighting limits of current theories. We discuss how models might be refined to better capture the dynamics of human statistical learning.

[S-4.3]

Learning regularities in noise engages both neural predictive activity and representational changes

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The ability to extract structured sensory patterns from a noisy environment is fundamental to cognition, yet how the brain learns complex regularities remains unclear. Using magnetoencephalography during a visuomotor task, we tracked the neural dynamics as humans learned non-adjacent temporal dependencies embedded in noise. We reveal that learning is supported by two temporally dissociable mechanisms. Neural predictive activity emerged rapidly, with stimulus-specific patterns appearing before stimulus onset and preceding measurable behavioral improvements. This is followed by a slower build-up of representational change, characterized by an increased neural pattern similarity between statistically dependent, non-adjacent elements. Both processes are supported by a distributed consortium of networks, with the sensorimotor and dorsal attentional networks playing a central role. These findings suggest that both neural predictive activity and representational changes contribute to learning regularities, revealing a temporal hierarchy in which neural predictive activity precedes behavioral improvement and is followed by neural representational changes, possibly facilitating the gradual consolidation of knowledge into stable neural representations.

[S-4.4]

Exploring sensitivity to network structures in sleeping neonates

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Humans make sense of the world by detecting regularities across multiple levels ranging from local statistics to global complex structures. Even in the first months of life, infants can track local statistical regularities. Higher-order regularities were long thought to depend on specialized cortical circuits not yet developed in early infancy. However, recent work suggests that a low-level associative learning mechanism may be sufficient to account for adult sensitivity to all levels of regularities.

To elucidate this question, we investigated whether neonates could be sensitive to complex network structures through an associative mechanism similar to the one described in adults. We passively presented 40 neonates with sequences of tones generated through a structured random walk within a two-cluster network, while recording their brain activity with EEG.

Using MVPA, we first confirmed that infants processed each tone of the sequence. Next, we revealed that the neonates indeed encoded the network structure by successfully decoding whether 2 successful tones remained in the same community or switched to another.

This study offers broader insights into the neural mechanisms supporting human sensitivity to higher-order regularities, potentially bridging our understanding of the learning mechanisms at different orders in a unified theoretical framework.

[OS-1.1]

Neural tracking of the rhythmic beat: a window on the detection of non-adjacent dependencies in adults and school-aged children

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Musical rhythm positively impacts grammar skills (Fiveash et al., 2021) by increasing sensitivity to prosodic cues that robustly signal syntax in natural speech (Degano et al., 2024). In the context of learning, we recently showed that beat-inducing rhythmic structure facilitates learning of non-adjacent dependencies in artificial languages (ALs) (Franzoia & De Diego-Balaguer, 2025). Here, we investigated the neural underpinnings of this facilitation using EEG in adults (N=47, age M=23.3, SD=3.8) and school-age children (N=43, age M=6.96, SD=0.96) exposed to three ALs varying in rhythmic structure (beat vs. non-beat inducing), presence vs. absence of non-adjacent dependencies, and their temporal alignment. Beat-frequency neural tracking measures were extracted to assess modulations induced when beat informs grammar-like structures. In children, we additionally collected measures of receptive grammar skills. Results showed enhanced beat-related neural tracking when rhythmic structure cued grammar-like regularities, in both groups. In children, inter-individual variability in beat-related neural measures was significantly associated with receptive grammar skills. These findings provide neural evidence that temporal predictability, sustained by neural tracking of rhythmic regularities, supports the detection of grammar-like rules, likely paralleling the facilitating role of prosodic regularities signalling syntactic structure in natural speech.

[OS-1.2]

Statistical Learning and Mathematics: Are Different Domains and Modalities of Statistical Learning Related to Different Math Skills?

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Statistical learning (SL) is widely recognized as a critical contributor to the acquisition of a wide range of cognitive skills. Overall, SL refers to the ability to extract regularities in how stimuli co-occur across space and time, in different domains (verbal or non-verbal) and modalities (auditory or visual). However, the potential role of SL in mathematical cognition remains largely underinvestigated. Given that mathematics is a multidimensional skill building on both verbal and visuospatial regularities, we hypothesized that the acquisition of different math abilities relies on different domains and/or modalities of SL. Participants (N = 78; university students) were evaluated on auditive-verbal and visual/visuospatial SL abilities, as well as on two basic math skills (order processing and geometry intuition) and on general math performance. The results of a path analysis showed that SL is related to basic math skills, which in turn are related to general math performance. Importantly, domain/modality-specific trends were observed, such that auditive-verbal and visuospatial SL were related to order processing and geometry intuition, respectively. These findings reveal a clear association between SL and mathematical cognition, and underline the importance of considering different domains and modalities of SL in relation to a multidimensional skill like mathematics.

[OS-1.3]

From Prediction to Feeling: The Embodied Predictive Dynamics in the Statistical Learning of Music

Tatsuya Daikoku [1]

[1] The University of Tokyo

Music has profoundly shaped the human experience, evoking powerful emotions that are intimately intertwined with bodily sensations and interoception—manifested in physical responses such as an accelerated heartbeat. Recent studies suggest that the brain's statistical learning plays a crucial role in generating musical emotion and its embodied correlates. However, the cognitive processes linking statistical learning to embodied emotional experience remain largely unexplored.

In this presentation, I will introduce our recent findings examining how the perception of musical chords elicits emotional and bodily responses through statistical learning. Using body-mapping experiments with 527 participants exposed to various chord progressions, we quantified how temporal fluctuations in musical uncertainty and surprise correspond to specific bodily sensations and affective experiences. We found that chord sequences characterized by distinct temporal dynamics of uncertainty and surprise induced sensations particularly in the cardiac and abdominal regions. Moreover, the intensity of cardiac sensations positively correlated with emotional valence and feeling of beauty.

These findings suggest that the hierarchical interplay between predictive uncertainty and musical surprise enables us to experience emotional pleasure. This research offers a theoretical framework for understanding how music integrates cognitive prediction and bodily feeling to generate emotion.

[OS-1.4]

Probing the role of statistical learning in language abilities with an individual differences approach

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Statistical learning (SL) has been proposed as a core mechanism underlying language acquisition and processing. However, evidence linking SL to linguistic skills is mixed, likely due to tasks that overlook SL's componential nature and rely on measures with limited reliability. To address this, we conducted two studies using SL tasks that directly assess sensitivity to linguistic regularities. In Study 1, 113 adult native French speakers completed measures of sensitivity to orthographic regularities in natural language and learning of novel orthographic patterns. Both tasks showed moderate-to-high split-half reliability and were significantly associated with spelling (Sensitivity: r = .27; Learning: r = .21), but not reading. The two SL measures were not correlated, raising questions about SL's construct validity. Study 2 adopts a latent-variable approach with 24 tasks to better capture shared variance. We hypothesize that language measures will cluster by timed versus untimed components, and SL tasks by linguistic versus non-linguistic domains. Structural equation modeling will test whether SL predicts language outcomes, with linguistic SL expected to be the stronger predictor. Pilot data with 175 adult English monolinguals showed good reliability, significant inter-task correlations (all r > .30), and a preliminary single-factor structure, supporting large-scale data collection (planned N = 300).

[OS-2.1]

Statistical learning induces neurodynamic adjustments to cortical speech encoding and affects speech motor control

Lori L. Holt [1], Timothy Murphy [2], Lin Zhou [1], Kyle Huffaker [3], Fernando Llanos [1] & Nazbanou Nozari [3]

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[2] University of Wisconsin-Madison

[3] Indiana Univeristy

Statistical learning across shifts in speech input distributions produces rapid adjustments in the perceptual weights with which acoustic cues inform vowel and consonant categorization. These changes are driven by prediction error relative to native language expectations that adjusts the effectiveness, or connection weight, of acoustic dimensions in activating native categories. Thus, native representations remain stable as statistical learning flexibly modulates the mapping from input to representation. This statistical learning induces neurodynamic adjustments to cortical speech encoding, with cascading effects on neural processing. These perceptual adjustments immediately impact motor speech control, shaping speech output during both auditory repetition and reading aloud. Crucially, this transfer to production is not mere mimicry. Passive exposure is sufficient to produce generalization of statistical learning in perception, but subtle task demands affect generalization and the transfer of learning to production. The results have implications for embedding statistical learning into sensorimotor models of speech, and for understanding the cognitive basis of alignment effects like phonetic convergence.

[OS-2.2]

Challenges to a Statistical Learning Approach to Reading

Jay Rueckl [1]

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Much of the interest in statistical learning stems from its promise as a core mechanism that is central to a wide range of cognitive domains. Reading is one such domain. From a statistical learning perspective, learning attunes readers to the structure of written language, and their sensitivity to this structure is reflected in multiple phenomena, including effects of stimulus properties on word and text processing, individual differences in reading outcomes, and cross-linguistic differences such as those associated with orthographic depth. The focus of this talk is not so much the substantial successes of the statistical learning approach to reading, but rather the methodological and theoretical challenges that may limit its continued progress. These challenges include difficulties in quantifying the statistical structure of written language; discrepancies between the "objective" structure of the language and the experiences of individual readers; variation in whether and how sensitivity to specific statistical regularities is expressed across contexts; and a broader mismatch between analytic approaches and theoretical traditions that aim to isolate the effects of distinct causal factors and a linguistic environment that contains numerous, often redundant, statistical regularities. Implications for theories of reading and conceptions of statistical learning will be discussed.

[OS-2.3]

Morpheme Learning in the Noisy Landscape of Natural Text

Kathy Rastle [1]

[1] Royal Holloway, University of London

Most words in English and other languages are formed by combining smaller meaningful units called morphemes. Understanding morphology allows us to generalise from known elements; for instance, we can interpret “quickify” because we know how the affix “-ify” changes the meanings of stems. This talk examines how we learn affix morphemes through reading experience. Because these units rarely appear on their own, their functions must be inferred from exposure to whole words. Theories propose that we learn affixes because they provide reliable information about meaning, but evidence has come largely from small laboratory studies or simulations. I present findings from corpus linguistics, computational modelling, and behavioural research investigating how affixes are learned from large-scale text input. The results show that affixes vary substantially in the ease with which they can be identified as combinatorial units in different words and the consistency with which they signal meaning. Results further show that these properties influence learning in both models and humans, such that acquired morpheme knowledge becomes a mirror of morpheme distribution defined orthographically in large-scale text. Overall, this work advances understanding of how statistical learning operates in naturalistic, noisy environments over the extended timescale of reading acquisition.

[OS-2.4]

Resolving Core Debates in Statistical Learning: Moving Beyond the Myth of Process Purity

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The field of statistical learning is built on a set of unresolved debates. Do executive functions support or interfere with statistical learning? Does SL improve with age or decline? Does sleep enhance the consolidation of statistical knowledge? And more recently, is mind wandering detrimental, or can it facilitate learning? At first glance, the literature feels inconsistent, even contradictory. The same constructs seem to produce opposite effects across studies. But what if the problem is not in the theories, but in what we are actually measuring? In this talk, I argue that these debates persist because we are asking the wrong question. SL tasks are not process-pure, as originally emphasized by Larry Jacoby. They do not isolate a single learning mechanism. Instead, they combine multiple processes (pattern extraction, attention, executive control, working memory) in different proportions. Once we take this seriously, the picture becomes clearer. Executive functions can either support or interfere, depending on task demands. Developmental trajectories and sleep-related effects shift with the composition of the process. Mind wandering—often treated as noise—can enhance learning when automatic processes dominate. The field does not suffer from inconsistent findings. It suffers from a measurement problem, and a process-dissociation framework offers a way out.

[OS-3.1]

Early Caregiver Predictability and the Developmental Origins of Individual Differences in Statistical Learning

Tess Forest [1], Khula Study Team [2], Laurel Gabard-Durnam [3], Kirsten Donald [2] & Dima Amso [1]

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Individuals differ dramatically in their statistical learning ability. In adults, these differences are predicted by how flexibly learners allocate attention toward information that is increasingly complex relative to their prior experience (Forest, Siegelman & Finn, 2021). But where do these important individual differences—in attention and statistical learning—come from? One possibility is that the predictability of our early experiences tunes the development of basic learning systems while the brain is highly malleable. To test this, we quantified the moment-to-moment predictability (entropy) of caregivers' behavior during naturalistic interaction with their 3-month-olds. Infants (N=222) preferentially attended to their caregiver when she was moderately predictable relative to herself, indicating that early attention, and our preference for moderate complexity, is calibrated to the statistics of one's unique early environment (Forest et al., 2025). Six months later, 103 of these infants completed an auditory statistical learning task during EEG: infants with more predictable caregivers showed larger neural indices of statistical learning (Forest et al., 2024). Together, these findings link early environmental structure to the development of core learning mechanisms, offering a developmental account of how statistical learning changes across the lifespan, operates in naturalistic environments, and how individual differences in basic learning mechanisms emerge.

[OS-3.2]

Like sponges: children's self-generated interactions soak optimal statistics for learning

Hadar Karmazyn-Raz [1] & Linda B. Smith [1]

[1] Indiana University

Young children are like sponges, soaking up meaningful patterns from a noisy world. While experimental studies show infants attend to statistical probabilities, the mechanisms by which they extract these from real-world experiences remain debated. We propose that learning is an emergent process where moment-to-moment interactions—such as where children reach and look—generate time-series that optimize statistics for learning and build structured knowledge systems over time.

We analyzed first-person toy-handling time series from infants (11–24 months) during repeated naturalistic play over four days. Network measures and distributional analyses revealed strong preferential structure: children repeatedly returned to a small set of "head" toys (hubs) rather than "tail" toys ($F(1,41)=51.02, p<.001$). Across days, connectivity increased for both head ($F(3,69) = 29.94$, $p < .001$) and tail toys ($F(3,69) = 32.24$, $p < .001$), generating increasingly skewed experience distributions.

We present a generative computational model nominating memory as the key mechanism driving these emergent patterns. By simulating time-series, the model demonstrates how memory-driven "soaking" dynamics stabilize hubs of experience while progressively integrating rare toys over time. This work links statistical learning with natural experiences, framing children's interactions as a sponge-like mechanism to uncover the meaningful patterns and latent structure of the world.

[OS-3.3]

Word search measures visual statistical learning and reading in children

Erin Isbilen [1], Noam Siegelman [2], Jay Rueckl [3 1], Kenneth Pugh [3 1] & Richard Aslin [1]

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Statistical learning (SL) is considered foundational to literacy, yet correlations between SL and reading are often mixed. This may arise from the fact that, while domain general, SL exhibits input-specific differences: learning in one modality does not consistently predict proficiency in another. Here, we present a novel, processing-based measure of statistical learning called the word search task. This task tests children's sensitivity to the orthographic regularities present in natural text—statistical information that reading fundamentally relies on. In this task, participants hunted for a single word hidden in an 8x8 grid of random letters. The target words varied on two statistical properties known to impact reading: word and bigram frequency. Word search performance positively predicted reading in 8-12-year-olds, above and beyond Orthographic Awareness, a reflection-based test of sensitivity to printed regularities. Unlike adults, who were more impacted by word frequency, children were significantly impacted by bigram frequency (the frequency of two letter combinations found in English words). These results underscore the limitations of reflection-based methods in forging connections between SL and language. They further highlight a developmental shift in sensitivity to the different statistical properties of text, and how sensitivity to such regularities scaffolds reading acquisition.

[OS-4.1]

Distinct statistical learning mechanisms support the acquisition of adjacent and nonadjacent dependencies

Laura Batterink [1], Daisy Li [1] & Daniela Herrera-Chaves [1]

[1] Western University

There are two broad classes of sequential regularities in continuous speech—adjacent dependencies, which occur between immediately neighbouring elements, and nonadjacent dependencies, which require learners to track relationships across distances. A longstanding yet still unresolved question is whether these two key types of regularities are supported by a single statistical learning mechanism, or by dissociable mechanisms. Here, we addressed this question using multiple indices of learning, including EEG neural tracking as well as explicit and implicit behavioural measures. Intriguingly, we found that adjacent and nonadjacent regularities produced strikingly different profiles of performance across our multiple measures of learning. Learning of adjacent regularities resulted in knowledge that could be readily expressed explicitly, but did not result in implicit facilitation on a performance-based measure of learning. In contrast, learning of nonadjacent regularities produced implicit knowledge only, without parallel acquisition of explicit memory. At the neural level, EEG-based entrainment to words during the learning phase best predicted explicit knowledge of adjacent regularities. Taken together, these results suggest that statistical learning of adjacent and nonadjacent dependencies produce separate types of representations. These results support the conclusion that distinct statistical learning mechanisms are involved in extracting adjacent and nonadjacent regularities from continuous speech.

[OS-4.2]

The role of attention in (statistical) learning differs across development

Amy Finn [1], Elena Greatti [2], Levi Antle [1 1] & Davide Crepaldi [2 2]

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[2] SISSA

Cognitive development is marked by age-related improvements, as young children tend to learn less (or worse) in most lab-based studies. However, there are clear cases in which children learn better than adults. I will present data from studies showing that these instances of child prowess can be explained (at least in part) by the ongoing development of attention. Using both direct and indirect measures of learning and neural entrainment, I will then show that attention shapes statistical learning differently across development. We presented 60 children (ages 8-10 years) and 60 adults with a continuous 8-minute stream of animal image triplets while recording EEG in either a full-attention condition or diverted-attention condition (during which participants were asked to perform a demanding 1-back task). Attentional diversion reduced triplet-level entrainment in both adults and children but enhanced neural entrainment to the image-level (or base) frequency in children only. These data show that attention is a critical factor to consider when evaluating statistical learning, gating outcomes in adults and children alike. However, these data also show that attentional diversion actually boosts children's neural sensitivity to the basic units of learning, with potential implications in the durability and quality of statistical learning over time.

[OS-4.3]

How experience shapes attention: Divergent neural signatures of Statistical and Reward Learning

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Experience allows humans to detect regularities in their environment, shaping attention and behaviour. Two sources of such attentional biases are statistical learning (SL) and reward learning (RL), which prioritize frequent or highly valued stimuli. Whether these processes rely on shared or distinct neural mechanisms remains unclear. To investigate this, we conducted a two-session EEG study using a visual search task tailored to separate SL from RL. In the SL-session, targets appeared more often at one location; in the RL-session, correct responses at certain locations yielded higher rewards. A task-irrelevant "ping" preceded each search display to probe any latent learned spatial biases. Behaviourally, SL and RL improved performance at high-frequency or high-reward locations. However, neural measures revealed dissociation. Multivariate decoding showed that only SL produced early spatial modulation during the ping period. Instead, RL influenced later processing: ERP analyses revealed larger SPCN for low-reward locations, reflecting greater discrimination demands. Pupillometry further differentiated the mechanisms: SL increased pupil dilation for low-frequency locations, while RL only produced an overall pupil increase, suggesting higher motivation. These findings indicate that SL and RL generate similar behavioural advantages through partly distinct neural pathways. SL shapes anticipatory spatial processing, whereas RL influences later value-driven decision stages.

[PS-1.1]

A Sign of Things to Come: Uncertainty Guides Temporal Attention in a Target-Detection Task

Yoel Sheinenson [1], Natan Ilani Shams [1], Tali Kleiman [1] & Noam Siegelman [1]

[1] Hebrew University of Jerusalem

Real-world environments include complex statistical structures; statistical learning (SL) therefore both depends on, and guides, our ability to detect which parts of the input to sample. An emerging view holds that sampling is determined by the uncertainty (i.e., entropy) implicated by different events in the sensory input. However, in most SL tasks, uncertainty and predictability (i.e., surprisal) are yoked, obscuring their distinct contributions to behavior. We therefore sought to disentangle their effects on attention allocation, using a visual SL paradigm combined with a target-detection task. In a first, two-experiment study (N=86, N=89), participants were exposed to structured streams of shape pairs, followed by a target detection for predictable and unpredictable items, preceded by predictive or non-predictive elements. We found that RT was not facilitated by target predictability, but by the predictive nature of its preceding stimulus (event entropy). In an ongoing study (N=200), we examine the time-course of these effects, with participants performing target-detection during exposure to quasi-regular inputs. Preliminary results show faster RT following lower event entropy (following predictive events), specifically when the input's overall uncertainty is high. Together, these findings suggest that SL shapes information sampling, highlighting its role in directing information foraging in complex environments.

[PS-1.2]

Absence of sex differences in implicit statistical learning

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Statistical learning, defined as the implicit extraction of environmental regularities, is considered a universal and evolutionarily conserved mechanism underlying predictive processing. However, whether it is modulated by sex remains unclear. This study examined potential sex-related differences in statistical learning in a large sample of young adults. We analyzed data from 473 participants who completed the Alternating Serial Reaction Time task featuring second-order non-adjacent dependencies, and compared performance between age-matched women and men. Robust statistical learning emerged across participants, demonstrating successful acquisition of environmental regularities. Sex did not influence the magnitude or progression of learning, and Bayesian analyses consistently supported the absence of sex effects. Small baseline differences in visuomotor performance were observed, with men showing slightly faster initial responses, but these differences diminished with practice and did not affect learning outcomes. Overall, the findings indicate that implicit statistical learning is largely resilient to sex-related variation. This robustness suggests that predictive learning relies on fundamental cognitive mechanisms that operate similarly across sexes.

[PS-1.3]

Beyond the Single Stream: Neural Entrainment to Two Artificial Languages in Bilinguals and Monolinguals

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Humans are adept at extracting statistical regularities. This mechanism, statistical learning (SL), is critical for language acquisition (Saffran et al., 1996). While word segmentation research typically tests monolinguals extracting co-occurring syllables from a single speech stream, real-world environments are increasingly multilingual. To address this gap, we investigate word segmentation in monolingual and bilingual 8-month-old infants and adults exposed to two sequential artificial speech streams. Previous bilingual SL research has primarily relied on offline behavioural methods with infants (e.g., Antovich & Graf Estes, 2018) and adults (e.g., Wang & Saffran, 2014). To capture the continuous dynamics of learning, we record online neural tracking during exposure (Batterink & Paller, 2017; Choi et al., 2020), alongside age-appropriate behavioural measures at test (looking time, accuracy, reaction time). Critically, the streams have partial phonetic overlap; therefore, if participants calculate transitional probabilities (TPs) across the combined streams, they will fail to demonstrate SL in the offline behavioural test. We hypothesize that monolinguals will entrain only to the first stream, showing no learning of the second one. We expect bilinguals to successfully extract words from both streams. We anticipate no significant differences in the trajectory patterns between adults and infants. Data collection is ongoing.

[PS-1.4]

Brain-like Representations in Predictive Coding Networks during Statistical Learning

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Deep neural networks (DNNs) are widely used to model visual processing, yet their potential to study learning mechanisms in the brain remains largely unexplored. While classical DNNs do not emphasize learning dynamics such as expectations or prediction errors, predictive coding (PC)-inspired DNNs explicitly capture these dynamics and may provide a promising framework for investigating learning mechanisms. Here, we explore whether PC-inspired DNNs can serve as biologically plausible models of learning in the brain. We compared two PC-inspired DNNs implementing predictive and contrastive training objectives and a supervised DNN against an untrained baseline in a simple recurrent neural network (RNN) architecture on a statistical learning task. Using representational similarity analysis, we compared model representations to human EEG data recorded during the same task. Our preliminary results show that representations of locally trained PC-inspired DNNs exhibit greater similarity to human EEG data than those of classical supervised DNNs and explain additional variance beyond classical DNNs. These findings suggest that PC-inspired DNNs capture learning dynamics reflected in human EEG data and provide initial evidence for their potential as models of brain-like learning.

[PS-1.5]

Children Use Distributional Morphosyntactic Cues to Infer Speaker Group Membership

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Children's statistical learning supports speech segmentation and word learning, yet its role in acquiring social meaning in language remains less well understood. We tested whether children map morphosyntactic cue distributions to speaker group membership using a semi-artificial language.

Five- to six-year-olds (N=40) heard two alien groups (Gulus, Norls) sharing English nouns but using distinct distributions of two novel plural markers ("ka," "po"). In the Deterministic condition, each group exclusively used one marker (Gulus: ka, Norls: po); in the Probabilistic condition, Gulus used "ka" 75%, and "po" 25%, while Norls used "po" 75%, and "ka" 25%.

During 48 exposure trials with feedback, children matched utterances to animal pictures. Across 12 test trials, participants categorized new speakers as Gulus or Norls based solely on marker-use patterns. Each test trial featured four plural utterances reflecting one group's distribution; in the Probabilistic condition, minority-marker positions were counterbalanced.

Children categorized speakers above chance overall (M=66.0%), driven by the Deterministic condition (M=82.5%); performance in the Probabilistic condition was at chance (M=49.6%). These findings suggest children leverage deterministic morphosyntactic patterns to infer group membership. This task provides a statistical-learning framework for studying how learners acquire socially meaningful linguistic variation.

[PS-1.6]

Decoding Patterns: EEG Insights into Auditory Statistical Learning in Norwegian Children

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Statistical learning (SL) is an implicit cognitive mechanism that enables individuals to detect patterns in sensory input across modalities. It is considered crucial for language acquisition, yet its role in language development remains debated, partly due to methodological differences.

Focusing on the implicit online component of this process, this study aims to contribute to a deeper understanding of how young children process statistical patterns in language-relevant input. We examined auditory SL in Norwegian preschoolers (ages 4-6), an underrepresented age group.

Using an implicit learning paradigm, electroencephalography (EEG) recorded neural responses to artificial syllable sequences organised into structured and random streams. Inter-trial phase coherence (ITPC) measured whether neural activity synchronised with the statistical structure of the stimuli, particularly at frequencies of the embedded word patterns.

This neural entrainment measure was complemented by an offline statistical recall task. Preliminary EEG results show a significant interaction between stimulus frequency and condition. ITPC was similar across conditions at the syllable frequency (3.3 Hz), whereas the structured condition showed higher ITPC at the word frequency (1.1 Hz). These findings suggest sensitivity to the statistical structure of the speech stream, with neural oscillations preferentially aligning to words when regularities are present, indicating mature-like entrainment in young children.

[PS-1.7]

Developmental trajectories of neural tracking of lexical-semantic features in children with cochlear implants

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Children acquire language through a gradual and hierarchical process moving from early sensitivity to acoustic cues to the extraction of higher-level lexical-semantic information. In children born profoundly deaf, auditory input is often limited until cochlear implantation, altering the timing of speech exposure. Studies have demonstrated the importance of early cochlear implantation for auditory cortex development and better linguistic outcomes (Sharma et al., 2002). Research has started examining neural tracking of continuous natural speech in children with cochlear implants (CI), focusing on low-level acoustic features (speech envelope; Federici et al., 2025). However, to what extent CI children develop the ability to track higher-level lexical-semantic features of speech remains unknown. Investigating higher-level representations in this population is essential to understand the constraints characterizing how the brain learns to extract features from natural speech. We investigated neural tracking of naturalistic speech in 24 CI children (3–17 years) and 24 typically developing (TD) age-matched peers. Participants listened to age-appropriate stories while brain activity was recorded using electroencephalography (EEG). Using the Temporal Response Function (TRF) approach, we model brain responses to speech features ranging from acoustic cues to lexical-semantic aspects of language. Analyses will consider both chronological age and duration of auditory experience.

[PS-1.8]

Dimensional reweighting in sound category learning

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Adapting to a new accent often involves reweighting perceptual dimensions that define the similarity space of speech sounds, so as to minimize sound categorization error. For example, voice onset time (VOT) and fundamental frequency (F0) are dimensions cueing the peer/beer contrast, whose weights differ in English and Korean: English listeners depend primarily on VOT, while Korean ones depend primarily on F0. These weights can be modeled as coefficients in a logistic perceptron predicting sound category. A dimension is downweighted when stimuli with different values on that dimension are paired with the same category feedback (e.g., 50% peer, 50% beer) while differences on another dimension predict the feedback (Harmon et al., 2019, Cognition; Kapatsinski et al., 2024, Cognition). The logistic perceptron model in Kapatsinski et al. (2024) predicts that downweighting should be most effective when the values in question are far apart, because this distribution tells the learners that even a large change in the dimension makes no difference in category assignment. We trained English listeners, recruited from Prolific (N=160), to downweight VOT, with either a 20 ms or a 60 ms difference between the trained values. More downweighting was observed when the VOT values were farther apart, supporting the prediction.

[PS-1.9]

Dynamic Transition Networks of Dyadic Toy Play

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Children's free-flowing, multimodal interactions with objects in uncontrolled, daily life support their cognitive development including language learning and controlled attention. Toy play provides children with opportunities to explore relationships between objects and build associations among them. Graph-theoretic analyses of the accumulated patterns of transitions among toys demonstrate that dyadic explorations of toys create small-world network structures which may promote efficient learning and generalized inferences. We examined how the statistical structure of associations between toys emerges from the moment-to-moment behaviors of children and parents.

55 1-4-year-olds (mean age = 24.21 months) played with a parent with 24 randomly distributed toys for about 10 minutes. Children and parents wore head-mounted eye-trackers. The toy on which gaze and hand actions were directed was coded by human coders with high reliability (Cohen's kappa = 0.96). Networks of toys (nodes) and transitions between toys (edges) were generated for children's gaze, handling, and joint gaze-handling. We examined 1) network growth over time, 2) how child and parent behaviors contribute to change in network structure (e.g., small-world, clustering, connectedness) and the evolving role of each node (e.g., degree, betweenness, node vitality), and 3) whether child age moderates the relationship between child behaviors and change in the network.

[PS-1.10]

Dyslexia is associated with a developmental lag in incidental statistical learning

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Incidental statistical learning occurs when structured input aligns with behaviorally relevant actions within an otherwise unrelated task (Roark et al., 2022). Under such conditions, complex auditory categories not learned through passive exposure can be acquired incidentally and generalized to novel exemplars after extended delays (Gabay et al., 2023). Adults with a history of dyslexia show proportionally poorer incidental learning—scaling with phonological impairment—than matched controls (Gabay & Holt, 2015), consistent with reduced efficiency of striatally mediated mechanisms supporting representational change (Lim et al., 2019). We examined learning of auditory statistical regularities in early adolescents (10–12 years) and young adults (18–30 years) with developmental dyslexia and matched controls. Early adolescent controls showed robust incidental learning and generalization comparable to young adult controls. Early adolescents with dyslexia, in contrast, did not learn. Young adults with dyslexia exhibited online learning but showed reduced generalization compared to adolescent or adult controls. This developmental lag in incidental statistical learning in dyslexia emerges even for nonspeech sounds indicating a domain-general learning vulnerability.

[PS-1.11]

Early sensitivity to zipfian structure: skewed distributions facilitate statistical word segmentation in infants

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Across languages, word frequency distributions follow a Zipfian power law, in which a small number of words occur very frequently while most occur rarely. Previous research shows that such skewed distributions facilitate word segmentation–a crucial milestone in language acquisition. However, experimental evidence for this facilitative effect only comes from older children and adults, leaving it open whether the effect reflects accumulated linguistic experience or is present early in development, impacting language learning. To address this, we conducted a statistical word segmentation study with 7- to 9-month-old infants. Infants were exposed to a continuous speech stream made up of four words where word frequencies followed either a skewed distribution or a uniform one (where all words occurred equally often). We found that infants in the skewed condition showed better learning than infants in the uniform condition (indicated by a larger difference in looking times between familiar and unfamiliar words). These findings suggest that skewed frequency distributions facilitate word segmentation already in infancy, indicating that this advantage does not depend on years of prior linguistic experience. Importantly, our findings also suggest that the widespread use of uniform frequency distributions in laboratory studies may underestimate infants' learning abilities.

[PS-1.12]

Evidence for spatial attention under uncertainty contexts: statistical learning effects in the Mexican-Hat Profile

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Spatial attention follows a "Mexican-hat" profile, with facilitation at the focus, suppression nearby, and recovery at greater distances. In a previous experiment Massironi et al. (2025) mapped visuo-spatial attention by asking participants to report the orientation of a "C" singleton appearing alone as a target (Baseline) or distractor (Probe) at varying distances from a central probed "C." Its probability of appearing adjacent to the central stimulus was manipulated to test whether learning would down-weight that position when the singleton was a distractor or up-weight it when it was a target, expecting performance to improve in the condition consistent with the specific reweighting mechanism and deteriorate in the other. Instead, results suggested a "zoom-out" of attentional focus, interpreted as a strategy to manage uncertainty about the singleton's identity. Now, in two follow-up experiments, uncertainty was reduced by making the singleton more likely to be a distractor or a target, expecting results to match the hypothesized down- and up-weighing mechanisms, respectively. When more likely to be a distractor, results again supported a zoom-out pattern; when more likely to be a target, findings were consistent with up-weighting. These results suggest SL effects depend on contextual uncertainty, potentially triggering conservative attentional adjustments.

[PS-1.13]

Exploring the interplay between DLPFC hemodynamics, statistical learning and mind wandering: an FNIRS study

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Statistical learning (SL) relies on the unsupervised extraction of environmental regularities, a process often hindered by the interference executive control. Although mind wandering (MW) is typically viewed as a failure of goal-directed attention, recent evidence suggests it represents a functional “offline” state that facilitates SL. Within a neurocompetition framework, we propose that MW enhances SL by transiently releasing executive constraints through downregulation of the dorsolateral prefrontal cortex (DLPFC), which otherwise competes with the acquisition of probabilistic structure. This study investigates whether MW reflects a neural state of attenuated executive involvement that facilitates SL. Participants completed a probabilistic learning task with second-order non-adjacent regularities (the Alternating Serial Reaction Time task), while MW was sampled via intermittent thought probes. Cortical hemodynamics were recorded using functional near-infrared spectroscopy. We hypothesize that MW during early acquisition is characterized by reduced DLPFC activation, and that the magnitude of this downregulation predicts enhanced SL. We present preliminary results from ongoing data collection, which support this proposed executive–learning trade-off. By integrating subjective reports with real-time neuroimaging, this study provides evidence for competitive interference of executive systems in SL and clarifies the adaptive utility of the wandering mind.

[PS-1.14]

Flexible statistical learning across modalities: Online and offline measures reveal different aspects of adaptation to changing regularities

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The ability to discern statistical regularities in our environments has been shown to support key cognitive functions. While most research on embedded pattern learning has focused on stable regularities, real-world patterns frequently change. Participants (N = 120) were exposed to both auditory and visual streams of embedded pairs that were implicitly and abruptly reshuffled into new pairs. We combined post-exposure (offline) learning measures with online target detection during exposure to gauge real-time learning and adaptation more directly. In the auditory modality, online target detection revealed learning of both the initial and the updated regularities, but with an advantage for learning the former. In contrast, the offline measure only evidenced recognition of initial patterns. In the visual modality, learning was not observed online but was revealed in sensitivity to both sets of regularities in the offline test. Our study provides evidence for flexible statistical learning of different types of sensory regularities under incidental learning conditions and underscores the non-overlapping information provided by on- and offline measures. In an ongoing fMRI study using a similar design, we aim to uncover the areas and functional connectivity patterns involved in this adaptation, as well as how neural representations are shaped and reshaped during exposure.

[PS-1.15]

Foreign Language Effect: A Triptych Framework

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Are you willing to sacrifice one person to save five? In this classical trolley moral dilemma, the Foreign Language effect (FLe) refers to bilinguals' tendency to make more deontological choices with the native language (L1), but more utilitarian choices with foreign languages (L2). FLe has been repeatedly found in various paradigms of moral and non-moral decisions. Nonetheless, a unified theoretical framework is yet to be established. Emotional involvement and the System 1/2 thinking strategy were the two common theories. In the current study, “psychological distance” was introduced by asking participants to respond to the names of themselves, a friend, and others. Forty-three Chinese-English bilinguals were recruited. Study 1 was to match symbols and names. FLe was found on “Self” condition. Study 2 was a subliminal attentional task. No effect was found. Study 3 was a memory test after a self-reference adjective-matching task. The accuracies were analyzed by L2 proficiency. FLe in the low L2 group was more significant. We therefore proposed a Triptych Framework. Awareness is necessary (study 2, Fold 1) for FLe. When it does exist, FLe works in a hierarchical fashion. Psychological distance works proximally (study 1, Fold 2); Other cognitive demands work distally (study 3, Fold 3).

[PS-1.16]

From co-occurrence to structure: seamless integration of space, time, and context in visual statistical learning

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Visual Statistical Learning (VSL) is typically investigated in isolation as either spatial or temporal learning, leaving open how these regularities interact when they co-occur in natural environments. Yet outside the laboratory, regularities unfold jointly across space and time and must be interpreted in context. Using a novel spatio-temporal paradigm in which spatially defined patterns dynamically moved in and out of view, with or without occluding elements, we examined how visual learning constructs structured internal descriptions from jointly available regularities.

We first replicated canonical spatial and temporal VSL effects within this integrated design. Crucially, learning reflected seamless integration of spatial and temporal statistics: behavior could not be explained by a simple additive combination of independent co-occurrence computations. Purely temporal regularities supported the construction of spatial structure, indicating cross-domain synthesis rather than parallel tracking. Moreover, motion-defined context and occlusion cues systematically shaped which regularities were learned from identical input, demonstrating that higher-level contextual biases are incorporated into the learning process in an equally integrated, non-linear manner.

Together, these findings reconceptualize VSL not as a passive recorder of isolated co-occurrences, but as a generative, interpretative process that selectively integrates spatio-temporal regularities with contextual biases to infer the latent structure of the environment.

[PS-1.17]

How underlying statistical structures modulate the neural response to rapid auditory sequences

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The brain is highly sensitive to auditory regularities and this is exploited in many scenarios from parsing complex auditory scenes, to language acquisition. To understand the impact of stimulus predictability on perception, it is important to determine how the detection of a predictable structure influences processing and attention. Here we probed how the brain response differs based on the predictability of an auditory sequence. Using an EEG paradigm we tested the neural response to sequences of 50ms tones arranged into a random order, a deterministic pattern or a probabilistic structure. In addition, we introduced deviant tones that were outside the spectral frequency of the main sequence, predicting based on previous evidence, that there would be a stronger deviant response in more predictable sequences.

We found that the brain rapidly detects the underlying structure. Furthermore, the sustained neural response is modulated by different forms of predictability. Finally, we demonstrate that the event-related response to deviant tones is influenced by both sequence type and the position of the deviant in the triplet structure. We discuss our findings in relation to cognitive resource allocation and the predictive coding framework.

[PS-1.18]

Inhibitory rTMS over the bilateral DLPFC modulates interference between competing statistical representations

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Recent evidence suggests that weaker executive functions and inhibitory repetitive transcranial magnetic stimulation (rTMS) over the dorsolateral prefrontal cortex (DLPFC) can enhance statistical learning. However, the role of the DLPFC in updating statistical representations remains unclear. We analyzed data from healthy participants performing a probabilistic sequence-learning task with second-order non-adjacent regularities, the Alternating Serial Response Task, across three consecutive days. Participants were exposed to two different sequences on the first and second day, and both were tested on the third day. On the second day, 1 Hz rTMS was applied over the right, left, bilateral DLPFC, and sham, in a between-subjects design. Our results show that compared to the other rTMS groups, the bilateral group achieved higher offline gains on day 3 for the day 1 sequence than for the day 2 sequence. These findings suggest that bilateral DLPFC rTMS supports the preservation and offline improvement of prior learning by minimizing interference from competing, newly acquired sequences. More broadly, reduced prefrontal engagement may act as a protective factor against interference in dynamically changing environments.

[PS-1.19]

Is Statistically-Based Chunking Unitary Across Levels of Linguistic Representation?

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There has been a longstanding tradition in the cognitive and language sciences to treat statistical learning (SL) as a unitary, domain-general ability that supports segmentation and related processing in broadly similar ways across cognitive domains. An alternative position suggests that SL may reflect multiple mechanisms tuned to the perceptual properties and statistical structure of the input. Under this view, sensitivity to local co-occurrence statistics may not necessarily align with sensitivity to broader higher-level regularities that support clausal-level processing. We addressed this by comparing two indices of sensitivity to distributional structure in English: (1) multiword chunk recall reflecting local co-occurrence regularities, and (2) clausal boundary placement reflecting longer-range statistical patterning. Participants' ability to recall statistically-governed three-word sequences was assessed in relation to performance on a boundary placement task. Across individuals, performance on the two tasks did not correlate, indicating that sensitivity to local co-occurrence statistics does not predict sensitivity to larger-scale statistical patterns. These results suggest that SL mechanisms may capture regularities differentially at distinct linguistic levels. Despite limitations in the tasks used, they nonetheless provide a useful starting point for future studies looking into the nature of SL across different levels of linguistic representation.

[PS-1.20]

Language Learning in a Stressful World: The role of Autonomic Nervous System Reactivity in Statistical Learning from Speech

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Background: Language learning in adulthood is intertwined with the dynamics of everyday life, in which periods of stress alternate with recovery. However, how these dynamics of stress and recovery shape individuals' ability to learn linguistic patterns and regularities remains unclear. Here, we investigated how individual differences in autonomic nervous system (ANS) reactivity to changes in the psychosocial environment affect statistical language learning (SLL).

Method: Sixty-five adults participated in a six-hour experiment incorporating stress and recovery periods, mimicking everyday life. Participants were exposed to novel speech streams in high- and low-stress contexts, with learning assessed immediately and around four hours later. We derived composite indices of sympathetic (SNS) and parasympathetic nervous system (PNS) reactivity from heart rate variability measures.

Results: Acute stress did not affect SLL at the group level. However, SLL ability was associated with ANS reactivity: participants with congruent SNS–PNS reactivity—either jointly high or jointly low—showed superior learning across contexts. SNS reactivity preferentially supported encoding, whereas PNS reactivity supported consolidation. Furthermore, the effect of SNS activation during speech exposure on learning depended on individuals' SNS reactivity profiles.

Conclusion. The findings demonstrate that individual differences in bodily regulation in a stressful environment are tightly linked with SLL.

[PS-1.21]

Learning pairs without awareness - differentiating symbolic from statistical learning

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In the last decades, the importance of statistical learning for language acquisition has been widely highlighted. However, this powerful mechanism does not take into account that learning can also be an inherently active process guided by attention. Indeed, when learning to link a label (L) to an object (O), adults and preverbal infants generalise from very few instances and spontaneously suppress the temporal order of presentation. What are the necessary conditions that bring us to learn bidirectional rather than unidirectional associations? Here, we explored the effect of conscious perception on learning label-object pairs. To do so, we ran the same experiment 1) behaviourally in adults (N=20) and 2) using EEG recordings in infants (N=25) in which participants learned to pair a label followed by an object. Half the labels were presented unconsciously using masking. We then assessed participants' ability to retrieve the associations in the canonical order (L->O) or in the reverse order (O->L), using behavioural tests or ERP measures. We expect that when the labels were presented below visibility threshold, the association learned will be only statistical whereas above threshold, the link created will be symbolic. This study brings insight on the properties of symbolic learning.

[PS-1.22]

Learning under ambiguity: structured training and working memory in cross-situational word learning

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Cross-situational word learning (CSWL) requires learners to resolve referential ambiguity by tracking word–referent co-occurrences across trials without feedback. Successful learning depends on at least two constraints: maintaining/updating competing hypotheses and reliably encoding speech contrasts. Most CSWL studies manipulate how exposure structure shapes learning; less attention has been paid to how changes in learners' representations and cognitive abilities constrain this process.

We examined whether intervening phonetic or lexical learning modulates subsequent CSWL, and whether this depends on working memory capacity. Adult Chinese-native beginner learners of Portuguese completed a baseline CSWL task (Day 1) using Portuguese pseudowords forming vowel minimal pairs, including difficult vowel height contrasts (e.g., /ke-kɛ/). Participants then received three days of phonetic (sound identification), lexical (word-picture mapping), or combined training. On Day 5, they completed a second CSWL task with both previously encountered and novel stimuli. Working memory was measured using an n-back task.

Preliminary findings (N=22) show no uniform CSWL improvement from pre- to post-training. However, training type interacted with working memory: in the phonetic training group, higher working memory predicted greater gains and stronger generalization. These results suggest that L2 statistical word learning under phonological difficulty depends on prior learning experience and memory-related evidence integration.

[PS-1.23]

Mind wandering dynamically regulates the interaction between implicit statistical learning and inhibitory control

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Mind wandering is frequently regarded as a cognitive disadvantage, as it can hinder executive functions such as inhibitory control. However, it might surprisingly improve statistical learning, which is the implicit acquisition of environmental regularities. This study examined the complex relationship among healthy young adults through a novel online task that incorporated assessments of mind wandering, inhibitory control, and statistical learning within a visuomotor framework. Our findings indicated a distinct divergence: increased mind wandering resulted in diminished inhibitory control while simultaneously facilitating probabilistic learning. Furthermore, we demonstrated that inhibitory control performance influences the impact of mind wandering on statistical learning. We propose that this effect may be modulated by frontal slow waves, which could disrupt decision-making networks while simultaneously enhancing neural activities that reinforce acquired patterns. These findings contest the exclusively negative perspective of mind wandering, underscoring its intricate and varied function in cognition.

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[PS-1.24]

Neural Phase Synchronization in Statistical Learning in Adulthood: Effects of Sequence Structure, Coarticulation, and Learning Trajectory

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Statistical structure in the environment shapes neural dynamics, and neural phase synchronization indexed by Inter-Trial Phase Coherence (ITPC), yet relatively little is known about the neural mechanisms underlying statistical learning (SL) in adults and the role of natural coarticulation. The present study investigated how structural regularity, coarticulation, and exposure influence neural phase synchronization, measured with EEG.

In a within-subject design, adults listened to four speech streams: structured and random streams, each presented either with natural coarticulation or with electronically concatenated syllables. In structured streams, syllables formed recurring trisyllabic “words” with high transitional probabilities within words and low probabilities across boundaries. In random streams, syllable order was pseudorandomized, preventing stable word formation. Coarticulated streams preserved natural acoustic transitions, whereas non-coarticulated streams removed these cues. Each condition was presented in two blocks.

Preliminary results suggested that ITPC at the word frequency was higher for structured than random streams, especially in the non-coarticulated condition. No clear structure effect emerged at the syllable frequency. Across blocks, ITPC changed only in the structured condition, while remaining stable in the random condition. Overall, the study provides insight into the effects of acoustic features and the temporal dynamics of the input on SL.

[PS-1.25]

Performance Sensitivity to Increased Complexity reduces Learning Effects on Rhythms' Self-reported Liking

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Playing music is a complex skill requiring the precise coordination of perceptual and motor processes, particularly in the temporal domain. The predictability of temporal information influences one's ability to monitor actions during performance. Additionally, statistical regularities are central to understanding the pleasure associated with music. However, little is known about how predictability—and its impact on action monitoring—shapes self-reported liking during rhythm production.

Seventy non musicians learned to synchronize with and reproduce nine rhythms varying in complexity according to the Information Dynamics of Music model, which approximates musical enculturation through transitional probabilities derived from a corpus of excerpts. Throughout the learning phase, participants rated their liking of each rhythm on a 10 point Likert scale. Ratings were analyzed based on the rhythms' predictability at the beginning and end of the task, while also accounting for each participant's sensitivity to predictability as estimated from their performance.

Preliminary results indicate that unpredictable rhythms are liked more after participants learn to produce them. However, this increase in liking is smaller when a participant's performance is more strongly impaired by the rhythm's structural complexity

[PS-1.26]

Presenting “Mega-SL”: A Large-Scale, Open Dataset for Statistical Learning Research

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While Statistical Learning (SL) has emerged as a key construct in the cognitive sciences, much of what we know about SL comes from paradigms that employ highly constrained statistical structures. This restricts our insight into how SL operates in real-world environments. To address this gap, we present the first SL “mega-study” (“Mega-SL”): A large-scale (N=424) publicly available dataset of visual SL performance across diverse statistical structures defined by distinct quasi-regular Transition Probability (TP) matrices. We describe the design of Mega-SL and present two illustrative analyses, testing core predictions of SL theory. First, we show that our proxy for learning (familiarity ratings for patterns of various TPs) increases with higher TPs, as broadly expected but rarely demonstrated in the field. Second, we show that patterns’ local statistical properties (i.e., TP) interact with the uncertainty of the environment in which they appear (i.e., entropy), with more pronounced TP effects in less noisy environments. Interestingly, however, we also show that fully regular patterns (TP=1) are similarly responded to across environments, which suggests a unique representational status. We discuss the implications of these findings and outline how further analyses of the openly available dataset can support more comprehensive and ecologically valid theories of SL.

[PS-1.27]

Referential adaptation in the face of changing input frequencies: The system wants to return to baseline

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Adults engage in statistical learning via adaptation at the referential level: In "Bob ran with Jim. He…", people assign "he" to Jim more often if they have recently seen many stories with pronouns referring to the second person, vs. the first. Can adaptation extend flexibly to multiple patterns in the input? Existing theories make conflicting predictions. In two experiments (Exp. 1 – written; Exp. 2- auditory), we examine referential adaptation with a between-subjects blocked priming paradigm, testing whether participants adapt to multiple referential patterns. Subjects saw two blocks of stimuli, with pronouns always referring to either the first or second person. Ambiguous test sentences measured the effect of exposure to each pattern. In both experiments, subjects adapted to both referential patterns. However, this effect was limited: participants adapted to the second exposure condition only when they encountered a low frequency referential pattern (pronoun-> second person) first. These results suggest that adaptation is most responsive to the initially identified distributional regularities; subsequent adjustments only occur when the input signals a return to the pattern that usually most frequent (pronoun->first). The importance of prior frequency biases and absence of inverse frequency effects in our data provide a serious challenge to error-based learning models.

[PS-1.28]

Sensitivity to Informative Print-to-Sound and Print-to-Meaning Regularities Predicts Reading Skill and Growth in Reading Disability

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Grounded in the Triangle Model of reading, we examined children's reliance on orthographic–phonological (O–P) regularities, orthographic–semantic consistency (OSC), and imageability in relation to reading skill and growth in 66 children (ages 7–14) with reading disability receiving school-based intervention. At the beginning (Time 1) and end (Time 2) of a one-year period, participants completed (a) an experimental task measuring sensitivity to O–P regularities, OSC, word frequency, and imageability, and (b) standardized assessments of word and pseudoword reading.

Regression analyses indicated that greater sensitivity to word frequency, OSC, and O–P at Time 1 predicted concurrent word-reading accuracy. Increases in OSC and decreases in imageability sensitivity over time were marginally associated with word-reading growth. Sensitivity to O–P consistency was related to concurrent pseudoword reading, and reduced sensitivity to imageability over time predicted pseudoword reading gains.

These findings replicate prior associations between sensitivity to regularities, reading skill, and reading growth (e.g., Siegelman et al., 2022) and extend this evidence to older children with reading disability receiving intensive intervention. Collectively, our findings indicate that greater reliance on informative regularities (O–P, OSC) and reduced reliance on less informative cues (imageability) are associated with stronger reading performance and growth.

[PS-1.29]

Speaker variability and task order effects in cross-situational statistical learning

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Cross-situational learning (CSL) tasks have typically relied on highly controlled single-speaker input, although real-world language learning requires adaptation to speaker variability (Frost et al., 2025). When speaker variability has been examined in CSL, it has often been manipulated together with other sources of variation, such as multiple object exemplars, making it difficult to determine whether any effects are due to speaker variability itself or to increased task complexity (e.g., Crespo & Kaushanskaya, 2024). Isolating speaker variability is therefore necessary to clarify its role in CSL.

Forty-one native speakers of Mandarin completed two blocked CSL tasks in a within-subjects design: one with a single speaker and one with multiple speakers. Task order was counterbalanced (Single→Multiple vs. Multiple→Single). On each trial, participants saw two novel objects, heard one pseudoword drawn from Ge et al. (2025), and selected its referent without feedback. Learning was assessed immediately and one week later. Results showed reliable learning in both conditions, but training and one-week-delayed-test performance were significantly higher in the single-speaker condition, suggesting multi-speaker processing costs.

Participants completing the single-speaker task first performed significantly better in the subsequent multiple-speaker test, indicating an order effect. This suggests initial speaker variability increases processing demands during CSL.

[PS-1.30]

Statistical language learning in adults: the role of individual differences in everyday executive functioning

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Statistical language learning (SLL)—the ability to extract probabilistic regularities from linguistic input—varies across individuals. The cognitive cost hypothesis suggests that, in adulthood, executive functions constrain implicit learning mechanisms, predicting that stronger executive functioning should relate to weaker implicit SLL. In this study, we examined the relationship between everyday executive functioning and SLL in young adults. Executive functioning was assessed using the Behavior Rating Inventory of Executive Function–Adult Version (BRIEF-A), capturing real-world executive abilities, and a digit span task measuring working memory capacity. Participants completed an auditory SLL task involving exposure to a continuous stream of trisyllabic pseudowords. Learning was tested with a two-alternative forced-choice (2AFC) task in which participants selected the familiar pseudoword over a foil and rated their confidence. Contrary to the cognitive cost hypothesis, executive functioning measures were not significantly correlated with overall 2AFC accuracy. However, metacognitive skills (as assessed by the BRIEF- A) moderated confidence-related performance: individuals with stronger metacognitive abilities showed higher accuracy on high-confidence relative to low-confidence trials, whereas this distinction was absent in those with weaker metacognitive skills. These findings suggest that individual differences in metacognitive skills may influence the balance between implicit and explicit knowledge acquisition.

[PS-1.31]

Statistical Learning Development Across Infancy and Caregiver Influence: An Optically Pumped Magnetometer Magnetoencephalography (OPM-MEG) Study Design and Pilot Results

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Statistical learning (SL) is foundational for early cognitive development (Saffran & Kirkham, 2018). However, open questions remain on how SL develops during infancy, how this development might differ across sensory modalities (Emberson et al., 2019), and how it might be shaped by infants' social environment (Choi et al., 2020). We utilize optically pumped magnetometer magnetoencephalography (OPM-MEG) to examine how auditory and visual SL change between 5 and 10 months of age. Combining OPM-MEG with frequency tagging enables continuous tracking of infants' learning curves as they acquire statistical regularities without requiring overt behavioral responses, making it well-suited for preverbal populations. In addition, we will assess caregiver predictability during caregiver-infant interaction to examine how it relates to SL at each age. Based on Emberson et al. (2019), we hypothesize that auditory SL curves will become steeper in 10-month-olds compared to 5-month-olds, while visual SL remains stable. Moreover, we hypothesize that higher caregiver predictability will be associated with steeper SL curves within each age group (cf. Forest et al., 2025; Choi et al., 2020). We aim to recruit 100 5-month-olds and 100 10-month-olds. At the conference, we will present the detailed study design and, where available, preliminary OPM-MEG data from pilot infant measurements.

[PS-1.32]

Statistical Learning in Math? Revisiting Proximity-Precedence Effects from Associative Learning Perspectives

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Extensive evidence shows the role of statistical learning in language/reading development, yet limited studies have explored its contributions to mathematical learning. The present study investigated whether statistical learning shaped the perception of mathematical structures. Our exploration is motivated by a well-documented phenomenon in math cognition, i.e., the proximity-precedence effect, which refers to the tendency to evaluate the narrowly spaced suboperation first (e.g., solve 1+3 × 4 as (1+3) × 4 = 16).

During an artificial order-of-operations learning experiment that mirrored real-world mathematical learning, college students were explicitly taught a two-step pattern generation rule. In Experiment 1 (N = 93) and Experiment 2 (N = 76), we manipulated the co-occurrence probability (100% vs. 0%; 75% vs. 25%) between proximity and visual symbols that signified the first step (i.e., high precedence).

We observed both typical and reversed proximity-precedence effects, each constrained by proximity-precedence co-occurrence probabilities. Moreover, solving artificial problems with wide spacing facilitated real-world algebraic reasoning, particularly when algebraic structures were obscured by atypical spacing.

Our findings suggest that, beyond stimulus-driven and rule-based, history-driven processing may also modulate the perception of mathematical structures. This interpretation highlights statistical learning as a fundamental mechanism underpinning broad aspects of human learning.

[PS-1.33]

Statistical Learning of multi-lingual conceptual structures

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Humans are remarkable statistical learners. Language is a prime example: from mere exposure, humans acquire complex semantic structures. When humans learn these structures from multilingual inputs, it is unclear whether they learn a conceptual structure that generalises across languages. Large language models (LLMs) trained on multilingual corpora offer a promising avenue to study this. Multilingual LLMs develop representations reportedly similar across languages. However, whether this reflects shared conceptual structure or surface-form overlap (e.g., shared roots) remains unknown. Here we disambiguate between these possibilities using Representational Similarity Analysis (RSA) over each layer of a multilingual LLM (mBERT), comparing representations of words and their translations across 21 languages. We ran RSA on 1) high-subword-overlap / concept-mismatched and 2) zero-subword-overlap / concept-matched word pairs. For RSA analysis across all language pairs, correlation of representations peaks in middle layers. The correlation for high-subword-overlap / concept-mismatched pairs peaks at early layers but drops drastically at middle layers, supporting concept-driven similarity. For zero-subword-overlap / concept-matched pairs, correlation shows a middle-layer peak. The results suggest that mBERT's cross-lingual similarity mainly stems from concept matching. This points to the emergence of a language-independent semantic structure under multilingual exposure; a property that is potentially shared with human multilingual learners.

[PS-1.34]

Statistical Regularities in Word Contexts Foster Word Learning

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Within the first few years of life, children go from nonverbal infants to fluent users of hundreds of words. This feat unfolds as children are immersed in a sea of words in conversations, stories and other language contexts. In principle, word contexts might support word learning because words similar in meaning tend to occur in similar surrounding contexts of other words. For example, fruit words tend to co-occur with “juicy”. Thus, a child who already knows some fruit words might learn that a “juicy mango” is also a fruit even without ever seeing a mango. Indeed, cutting-edge large language models leverage just these statistical regularities in word contexts to form rich representations of words. Yet, we do not know whether these context cues are an important driver of real-world word learning. We therefore constructed two new metrics designed to quantify these context cues in children’s everyday language input. Across analyses of both typical word age of acquisition and longitudinal increases in word knowledge, both context cue metrics convergently predicted real-world word learning. Moreover, this prediction held above and beyond other established predictors such as word frequency and concreteness. These findings illuminate how word learning is scaffolded by everyday language.

[PS-1.35]

Statistical Structure and Representation Consistency Shape Feature Memory

Lotta Pesonen [1] & Jozsef Fiser [1]

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Chunking through statistical learning reportedly biases memory for features of chunked items toward each other. We examined how this bias depends on the strength and consistency of participants' internal representations.

Across two experiments, participants completed a familiarization phase in which they uncovered hidden target objects in a grid based on a cue object. Cue–target pairs followed unknown spatial pairings with 100%, 80%, and 0% predictability in the Perfect, Partial, and Random conditions, respectively. On each trial, object colours were sampled from unique, object-specific distributions. Familiarization consisted of object–cue pairs with either Perfect and Partial (Exp1, N=20) or Perfect and Random structures (Exp2, N=18), presented in intermixed trials.Following familiarization, participants provided four estimates of each object's typical colour, yielding two measures: deviation from the distribution mean (precision) and response variance (consistency).

Memory bias toward the paired colour emerged only in low-consistency estimates for Perfect and Random stimuli. High-consistency reports clustered around the true colour mean, suggesting that previously reported biases arise primarily from less precise representations. In contrast, consistent reports for Partial stimuli were biased away from the paired colour, whereas less consistent reports centred on the true mean, indicating that rule violations modify chunked item representations.

[PS-1.36]

Strategic Flexibility in Orthographic Mapping: How Task Context Modulates Radical Sensitivity

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Most modern Chinese characters are phonograms combining semantic and phonetic radicals horizontally. While readers are sensitive to these components, it remains unclear how this sensitivity adapts during novel word-referent mapping. We conducted four experiments where proficient Chinese readers learned associations between pseudo-phonograms and novel objects in an artificial lexicon task, a type of cross-situational learning paradigm. In Experiment 1, which featured transparent semantic/consistent phonetic radicals, participants mapped one phonogram to two competing referents in the study phase. The results showed that reliance on phonetic over semantic radicals positively predicted learning performance. However, when mapping one referent to two competing phonograms with transparent semantic radicals, a preference for semantic over phonetic radicals emerged, regardless of the consistency of phonetic radicals (high in Exp. 2, and low in Exp. 3). When semantic radicals were less transparent (Exp. 4), the relationship between radical reliance and learning performance disappeared. These results demonstrate that Chinese readers do not apply radical sensitivities rigidly. Instead, they flexibly adapt to radical functions and regularities based on specific task demands. This highlights a dynamic link between orthographic experience and statistical learning, where the perceived utility of semantic versus phonetic information is weighted according to the learning context.

[PS-1.37]

The effects of type and token frequency on semantic extension

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Linguistic productivity would seem to be a type of extension. Whereas semantic extension involves extending a form to a new semantic context (e.g., extending -ed from the past participle use to the simple past tense use), productivity involves extending a form to a new formal context (e.g., extending -ed to the verb help; previously, holp). However, the statistical drivers of the two processes are thought to be different: token frequency for semantic extension and type frequency for productivity (Bybee, 2001). However, no research examined the determinants of extension and productivity empirically within the same study. We exposed learners to a miniature artificial language that had two plural and two diminutive suffixes. One of these suffixes (counterbalanced) was more frequent than others. This advantage was either in type frequency, token frequency, or both. In training, learners encountered non-diminutive plurals, non-diminutive singulars, and diminutive singulars, but never diminutive plurals. To test productivity, we evaluated suffix choice given familiar meanings and novel noun stems. To test extension, we evaluated suffix choice given the novel diminutive plural meaning. Productivity and extension were influenced by the frequency variables in the same direction, suggesting they are the same phenomenon. A connectionist model supports this interpretation.

[PS-1.38]

The Impacts of Impact: Head Trauma's Relationship to Statistical Learning

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Head trauma disrupts language processing, yet the cognitive mechanisms underlying these deficits remain unclear. While working memory impairment is well-documented following concussion, statistical learning (SL) may represent a linked, underexplored pathway from injury to language difficulty. The present study compares individuals in three groups (no history of head trauma, history of mild head trauma, and history of severe head trauma) on the Statistically Induced Chunking Recall (SICR) task, a reliable memory-based measure of SL, as well as the Two-Alternative Forced Choice (2AFC) task to provide additional statistics corresponding with SL. Based on prior evidence from stroke populations and the established WM-SL linkage, we predict that individuals with severe head-trauma history will demonstrate reduced SICR performance. Data collection and analysis are currently underway, with completion anticipated by this May. Preliminary data is promising, with participants in each of the three categories suggesting that individuals with histories of severe head injury have lower average scores on both 2AFC (percent correct) and SICR (trigram difference) compared to controls. Identifying SL impairment as a mediator of post-concussion language deficits would illuminate a possible cognitive pathway, informing more targeted assessment for the millions affected by head trauma annually, especially those suffering from post-concussion language deficit.

[PS-1.39]

The Role of Environmental Responsiveness in Infant Language Learning

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Prior research suggests children differ in their statistical learning abilities; however, the factors driving these differences remain understudied. This ongoing study investigates whether the responsiveness of an infant's environment explains individual differences in their statistical learning ability. In our task, we manipulate the responsiveness of infants' environments based on their experience controlling a computer screen using their eye movement prior to a statistical learning task. For half of the infants, the screen responds to their eye movements (e.g., when they look at an image of a pond, a duck pops out). The other half cannot control the screen, and see a recording of the screen elicited by a yoked infant in the responsive condition. Next, in the statistical learning task, we measure infants' ability to anticipate an upcoming word as they gain exposure to predictable adjective-noun pairs (e.g., "silly birdie" and "happy piggy"). Our pilot data included children in the responsive environment and suggested that infants can predict the adjective-noun pairs. We are currently collecting a full sample of infants in both conditions. We hypothesize that infants' opportunities to engage with a responsive environment are one of the factors underlying individual differences in statistical learning ability.

[PS-1.40]

When faced with foreign accent: Exploring the development of receptive and productive phonemic recalibration

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Adult listeners are known to tune their phonemic categories when exposed to talkers with accents or otherwise unique productions. Here, we examine the development of this recalibration mechanism in children ages 5-8 years of age and test whether perceptual accommodation of accented speech transfers to production. First language (L1) Spanish children were exposed to American English-accented (i.e., foreign-accented) Spanish during a memory game. Embedded within the game's word list were critical accented sounds, /b/ and /p/, presented in onset position. To assess shifts in production, children completed a picture naming task with CVCV words starting with /b/ and /p/. Results of the receptive task differed from prior work in adult listeners for all age groups; recalibration of the boundary toward English values was not observed, though there was flattening of the identification functions. Production results showed reduced variability in /b/ productions but not in /p/, suggesting greater transfer for prevoiced sounds (/b/), which are typically more variable than short-lag (/p/) sounds. The results suggest reduced perceptual certainty and selective changes in production variability after accent exposure, suggesting that either more extensive exposure is needed to prompt adult-like boundary recalibration or that the mechanism supporting sound category adaptation is still developing.

[PS-1.41]

When statistics are informative, does tone matter?

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Statistical speech segmentation requires integrating multiple cues. Speakers of non-tonal languages use transitional probabilities (TPs) to infer word boundaries. In tonal languages, both segmental and tonal features define syllables. Here, we dissociated TPs at segmental and tonal levels to determine their relative roles in segmentation.

In a preregistered study, ninety-six native Mandarin speakers were randomly assigned to one of three artificial language conditions and listened to a 15-minute continuous speech stream while performing a drawing task to encourage incidental learning. All conditions had identical segmental TPs but differed in tones: Constant-tone (no tonal contrast), Boundary-tone (Mandarin Tone 4 marking word-final syllables), and Unstructured-tone (tones randomly assigned). Segmentation was assessed using a two-alternative forced-choice familiarity task. In the tonal conditions, a transfer block reassigned tones at test to dissociate reliance on tonal patterns from syllable sequences.

Participants segmented above chance in all conditions. Accuracy did not differ across tonal structures, indicating that tonal marking did not facilitate learning when segmental TPs were informative. Strikingly, performance was higher when tones were reassigned at test, demonstrating that learners encoded segmental TPs over tonal TPs, or processed segmental and tonal information holistically. These findings constrain models of cue integration and competition in statistical learning.

[PS-1.42]

Who Benefits from Sleep? Individual Differences in the Consolidation of Second Language Grammar

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Sleep supports the consolidation of newly learned statistical patterns, yet individuals vary in the extent to which learning benefits from offline processing (Diekelmann et al., 2009; Robertson et al., 2004; Song & Cohen, 2014). Prior research shows that sleep-related improvements in L2 grammar learning emerge mainly when learners develop awareness of underlying rules before sleep, suggesting that consolidation preferentially operates on representations that have reached a more explicit or declarative state (Kim & Fenn, 2020). The present study examines whether individual differences in cognitive abilities predict variability in sleep-dependent consolidation of grammatical knowledge.

One-hundred participants were trained on a semi-artificial language (Rebuschat, 2008) and completed grammaticality judgment tests immediately after training and following a retention interval filled with either sleep or wakefulness. Individual differences were assessed using a cognitive battery measuring working memory capacity (Operation Span, Reading Span), executive planning (Tower of London), and paired-associate learning (MLAT5) abilities. Those aware of the patterns prior to sleep benefited from offline consolidation. A Bayesian multilevel model will further test whether cognitive abilities predict consolidation-related changes in language performance. We hypothesize that declarative memory will predict initial incidental learning, whereas working memory will predict overnight improvement in rule generalization.

[PS-2.1]

(No need to) mind the beat: Statistical learning with non-isochronous sequences

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In the classical segmentation paradigm used to study statistical learning (SL), stimuli are typically presented isochronously, and in EEG frequency tagging studies, spectral peaks emerging at the pattern frequency have been viewed as a neural signature of SL. Recently, it has been proposed that this neural alignment to the pattern frequency may not merely reflect, but functionally support SL, motivated in part by work showing that neural tracking of quasi-rhythmic structure in natural speech enhances intelligibility (Batterink et al., 2024). However, such tracking is thought to lean on temporal expectations (Rimmele et al., 2018). Here, participants were exposed to streams of novel visual shapes (n = 60) and auditory syllables (n = 60) organized into recurring duplets. Stimulus-onset asynchrony (SOA) was non-isochronous, eliminating a regular beat. Pattern-onset asynchrony (POA) was manipulated within participants to be either isochronous or non-isochronous, thereby preserving or disrupting pattern-onset regularity, while keeping statistical structure and local temporal predictability constant. Post-exposure behavioral tests revealed robust SL across modalities, with comparable performance between POA conditions. These findings suggest that SL survives when temporal cues are unreliable at both the stimulus and pattern level, and motivate reconsideration of how spectral peaks at the pattern frequency should be interpreted.

[PS-2.2]

Beyond Accuracy: Modeling Inter-Item Dependencies to Measure Independent Statistical Learning

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Artificial grammar learning (AGL) tasks target learning efficiency as a single latent ability. However, as test items are instantiations of the same set of rules, they cannot be independent. Consequently, summing raw accuracy scores - assuming independence - can overestimate learning by counting redundant knowledge of tightly linked patterns as separate evidence of learning.

We introduce a scoring algorithm that models the relational structure among test items using pointwise mutual information (PMI). Inter-item dependencies are estimated at the sample level, and individual item contributions are selectively downweighted when strongly predictable from other learned items. This procedure yields an estimate of the effective number of independently acquired linguistic patterns rather than total correct responses.

Applied to previously published AGL data (Lukács et al., 2026), the algorithm significantly outperformed raw accuracy and principal component–based approaches in predicting independent statistical learning outcomes. Improvements were particularly pronounced in comprehension-based (forced-choice) tasks (correlation = 0.26 → 0.36).

These findings suggest that statistical learning capacity is better characterized by structural diversity of acquired representations than by overall familiarity. Modeling item interdependencies provides a principled alternative to classical scoring and offers a new framework for studying individual differences in statistical learning.

[PS-2.3]

Bilingual Artificial Grammar Learning: The Role of Indexical Cues in the Simultaneous Acquisition of Multiple Rule Structures

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The vast majority of statistical learning research has explored these mechanisms in a monolingual context, despite the fact that the majority of the world is multilingual. This begs the question of how implicit learning mechanisms can track multiple statistical structures simultaneously. In the context of artificial grammar learning (AGL), the limited evidence to date suggests that adults are unsuccessful in tracking multiple grammars when composed of speech stimuli. In contrast, research in the domain of word segmentation has found it is possible to segment multiple speech streams simultaneously, but to do so may require some form of indexical cue (e.g. the speaker's face) to facilitate the encapsulation of separate statistical representations. In the present study, we extended this logic to the domain of rule learning. In a series of AGL tasks with speech stimuli, we tested adults' ability to learn two artificial grammars simultaneously, both with and without an indexical cue of the speaker's face. In contrast to previous AGL studies, we found that adults learned both grammars successfully, even when there was partial overlap in the syllable inventory of the two grammars. Moreover, consistent with segmentation studies, indexical information appears to facilitate the acquisition of multiple structures.

[PS-2.4]

Can children learn nouns and verbs simultaneously from cross-situational statistics?

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Cross-situational statistical learning (CSSL) is a powerful source of information for acquiring word-referent mappings, but typically CSSL studies present either noun-object or verb-action mappings, and avoid the naturalistic additional ambiguity of both occurring together. Monaghan et al. (2015) showed that adult learners can acquire both nouns and verbs simultaneously through CSSL when noun-verb pairs were presented with moving objects. In this study, we tested whether children aged 3;2 to 4;2 years could also learn these noun-verb object-action mappings.

53 children heard a phrase and saw two scenes of moving objects. 30 children in the syntax condition heard the noun and verb in a sentence frame (“the X is Y-ing”), 23 children in the no-syntax condition heard only a noun and verb ("X Y"). After CSSL exposure, testing trials isolated learning of nouns and verbs.

Across both conditions, children were able to acquire both nouns and verbs. Learning was better in the syntax than no-syntax condition, and older children learned better than younger children. The results demonstrate that young children can use CSSL even when there is extra ambiguity of different grammatical categories of words, but that availability of syntactic cues seems to boost this learning.

[PS-2.5]

Children's sensitivity to natural language statistics predicts expressive and receptive language skills

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Statistical learning is widely theorized to support language acquisition, yet most evidence comes from artificial-language paradigms that only approximate the distributional structure of everyday speech. We developed a phonemic serial recall task (PSRT) to index children's sensitivity to natural language statistics derived from the Child Language Data Exchange System (CHILDES). In a web-based longitudinal design, 54 neurotypical native English–speaking children (4.88–10.60 years) completed the PSRT at two sessions separated by 4–8 months; at Session 2 they also completed standardized measures of expressive language (Redmond Sentence Recall; TILLS Nonword Repetition) and receptive language (sentence comprehension). PSRT stimuli comprised six-syllable sequences built from high-frequency versus low-frequency CVCV bigrams in child-directed speech from North American English. Performance was scored as the number of correctly reproduced bigrams, reflecting the task's frequency manipulation. Children recalled significantly more bigrams for target (high-frequency) than foil (low-frequency) sequences, supporting construct validity. Internal consistency was good-to-excellent and test–retest reliability was moderate. Crucially, target (but not foil) PSRT score predicted stronger nonword repetition and sentence recall and was associated with higher sentence comprehension accuracy. Together, these findings suggest that sensitivity to real-world phonotactic statistics is measurable and is meaningfully linked to individual differences in children's expressive and receptive language skills.

[PS-2.6]

Critical periods cannot wait: visually driven phonetic encoding in the absence of hearing

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The first year of life represents a critical period for the acquisition of native phonetic categories. Whether this period is triggered by auditory input remains unclear. To address this question, we recorded EEG responses to continuous auditory and audiovisual speech in 38 children whose hearing was restored through cochlear implants (CIs) and in 37 age-matched hearing controls (HC). Half of the CI participants were congenitally deaf and experienced auditory deprivation throughout the first year of life, while others acquired deafness (AD) later in development and were therefore exposed to speech during the typical window for phonetic attunement. Using multivariate temporal response function modelling, we predicted neural activity from hierarchical acoustic-to-phonetic speech features, including the sound envelope, phoneme onsets, and phonetic features. To examine the role of early sensory experience, we tested phonemic contrasts that are auditorily distinct but visually indistinguishable (e.g., /b/vs./p/) and contrasts that can be discriminated visually (e.g.,/m/vs./n/). During audio-only speech, auditory phonetic features enhanced neural speech processing only in HC and AD groups, whereas all groups benefited from visual phonetic features during audiovisual speech. Results indicate that the critical period for phonetic attunement is guided by a modality-flexible biological-predisposition for speech signals and not by auditory input.

[PS-2.7]

Cross-Modal Transfer in Statistical Learning: Investigating Directionality under Unimodal Learning conditions

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Information in the environment is often multimodal and provides the learner with temporally synchronous combinations of sensory stimulation. As a result, when learners extract structure from multimodal information, the correlation between cross-modal sensory cues provides redundancy that could enable cross-modality transfer via modality-general representations. Prior studies report mixed findings and have mainly examined simultaneous multimodal input, leaving cross-modal transfer following sequential unimodal learning largely unexplored.

Here we asked whether SL generalizes across modalities, whether transfer is direction-dependent, and whether learning order influences performance. Forty adults completed an artificial language learning experiment in which two distinct languages were learned sequentially in counterbalanced modality orders (Aud–Vis; Vis–Aud). Each familiarization stream consisted of four tri-syllabic words. Learning was assessed with a 2AFC task and a SICR task (Isbilen et al., 2020), administered in modality-match and -mismatch conditions.

Results showed robust cross-modal transfer, with no reliable direction effects. Interaction analyses indicated that transfer depended on learning order ($p=.02$) and training modality ($p=.003$).

These results support a modality-general mechanism of SL that enables robust cross-modal transfer, but with considerable individual variability, highlighting the importance of examining individual learning profiles to better understand how transfer modality, direction, and learning order shape performance.

[PS-2.8]

Dissociable dynamic effects of expectation during statistical learning across cortical layers

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The brain seemingly generates internal predictions to optimise behaviour. Predictive processing has been demonstrated in non-invasive human studies and in animal models. Typically, neural responses to expected stimuli are suppressed - however, these findings can be supported by various mechanisms. Our recent EEG findings show that predictive processing during statistical learning is dynamic across short and long time scales. In this high-field neuroimaging study, we test if these dissociable dynamics of expectation effects can be mapped onto different levels of cortical hierarchy. Healthy volunteers (N=12) performed an associative learning task whereby a visual cue predicted an auditory stimulus with 75% validity. GLM analyses comparing activity evoked by valid versus invalid sounds showed increased response to invalid sounds across the primary auditory cortex. Multivariate SVM analyses assessed decoding accuracy for valid versus invalid trials across cortical hierarchy levels and layers, and compared early versus late learning phases. This analysis showed significant decoding of validity in pars triangularis early during learning, and the dentate gyrus late during learning. These results map the previously reported dynamic effects of stimulus prediction onto different levels of the cortical processing hierarchy, and specify the role of the hippocampus in statistical learning.

[PS-2.9]

Does the left articulatory-motor cortex contribute to statistical language learning? A rTMS-EEG study

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Background: The speech motor system has been proposed to contribute to statistical language learning (SLL), since articulatory suppression impairs SLL. We used brain stimulation to investigate the role of the left articulatory-motor cortex (L-AMC) in SLL with and without prosodic cues. Methods: Repetitive magnetic transcranial stimulation (rTMS) was applied to the L-AMC/control area. After stimulation, participants listened to structured speech streams with and without prosodic cues while EEG was recorded. A third group completed the task without TMS (EEG only). Online learning was investigated by measuring neural entrainment to repeating word-forms, and offline learning with a 2AFC task immediately and on the next day. Results: Preliminary analyses suggest that in the control groups, learning was boosted by prosody, but this was not accompanied by a neural entrainment difference. Compared to controls, L-AMC stimulation enhanced learning in the flat but not in the prosodic condition, abolishing the boost from prosody. Neural entrainment in the flat condition was also enhanced in the L-AMC group compared to controls (trend). Learning results were sustained to the next day in all groups. Conclusions: The L-AMC might contribute to novel word-form learning from continuous speech. This contribution is, nevertheless, small compared to individual variation in learning.

[PS-2.10]

Double Trouble: The Learning of Multiple Mappings in the Context of Cross Situational Word Learning

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A key task for language learners is to determine which referents reliably co-occur with specific words. Numerous studies have shown that adults and infants can learn word–referent mappings (1:1) from cross-situational statistics. However, natural language learning often involves greater complexity, such as homonyms, where one word maps to multiple referents (1:2), and synonyms, where multiple words map to the same referent (2:1). We investigated how learning differs across these three conditions. Participants were randomly assigned to one of the three groups and learned word–referent mappings over several training blocks followed by a test phase. Results showed that overall performance was above chance in all groups. However, one-to-one form–meaning mappings were learned significantly more efficiently than mappings involving any type of ambiguity. Moreover, the specific direction of ambiguity mattered less than the mere presence of competition. That is, in the absence of feedback, only the 1:1 condition showed continued improvement across blocks, whereas performance in the 2:1 and 1:2 conditions plateaued and did not differ from one another. The continued difficulty with homonym and synonym mappings points to more than just slower learning; the plateau suggests that learners may require additional cues to resolve competition.

[PS-2.11]

Element duration biases statistical chunking across vision and audition

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During conscious learning, observers prioritize which aspects of the input to learn in an efficient, goal-directed manner. Statistical learning (SL) unconsciously extracts and represents patterns of individual elements, or "chunks," from the environment. However, it remains unknown whether this automatic processing also follows a biased learning strategy, as higher-level learning does.

We hypothesized the existence of general chunking principles in SL that operate at the lowest perceptual level across sensory attributes and modalities when extracting statistical regularities. To test this, we relied on the Iambic–Trochaic Law (ITL), which posits that in auditory sequences, an element with longer duration signals the end of a segment to the observer, leading to decreased accuracy in detecting perceptual changes at segment boundaries.

We implemented the same stream-segregation paradigm in audition and vision to explore the generality of the ITL. Simple tones or basic visual objects of 200 ms and 600 ms duration were presented in a stream of three-element repeating pattern in a go/no-go paradigm with the task of detecting changes in gap duration. Participants exhibited similar boundary-related sensitivity changes in both modalities, confirming the "longer-last" principle. These findings suggest modality-independent duration-based chunking mechanisms.

[PS-2.12]

Exploration-Exploitation Strategy in Visual Statistical Learning: an EEG Study

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In statistical learning, individuals form a dual strategy of exploration with more cognitive resources toward low predictive cues, and exploitation with more cognitive resources to highly predictive cues. However, whether an exploration or exploitation strategy is preferred during statistical learning remains unclear. This study aimed to investigate the neural evidence of exploration-exploitation strategy in visual statistical learning process.

Seventy two neurotypical adults (40 females, Mage = 22.36 ± 1.99 years) performed a visual cue target task to press different keys in response to each target. Cue predictability for a specific target varied across high (100%), moderate (75%), and low (50%) levels.

Repeated-measures ANOVA showed a significant higher accuracy and shorter RT for high compared to other predictability conditions. Event-related potential results showed a significant smaller frontal N1 (80-160ms) and N200 (200-300ms) for high compared to low predictability. Parietal N400 (300-700ms) was significantly larger for moderate predictability and smallest for high predictability. Cluster-based permutation analysis identified one time window (344-540ms) over the frontal region with greater negative power for the high predictability (1-19Hz).

The results indicate that processing efficiency was higher and fewer cognitive resources were allocated for highly predictable cues, suggesting the exploration strategy in visual statistical learning task.

[PS-2.13]

Follow the Dot: A New Scalable Mouse-Tracking Method for Studying Sequence Learning in Real Time

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Statistical learning (SL)—the extraction of regularities from continuous input—is widely implicated in language, perception, and action. However, dominant paradigms rely on post-exposure recognition tests or block-averaged reaction times, which provide limited insight into how learning unfolds. Temporal dynamics offer a sharper test than traditional measures, detecting differences between even closely related theoretical accounts that otherwise appear indistinguishable.

We introduce a new real-time paradigm that captures anticipatory processing and formally launch mouse-tracking as a scalable method for studying SL. In a visual "Follow-the-Dot Paradigm," participants are given a brief anticipation window prior to each stimulus, enabling attentional shifts toward upcoming items. Mouse position during this window provide a continuous, trial-by-trial index of emerging predictions. We validate the paradigm in two studies (each with N=36) varying sequence length (2- and 4-unit), and repeat them with an otherwise identical procedure using anticipatory gaze to test for any effect of mouse tracking on performance. Critically, participants showed equivalent learning across eye- and mouse-based measures, with both methods revealing reliable anticipatory shifts to predictable sequences. We discuss how mouse tracking offers a scalable, resource-efficient approach without sacrificing accuracy, as well as how the paradigm can be used to test key statistical learning mechanisms.

[PS-2.14]

How Affix Order Affects Learning in Ambiguous Contexts

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Language is learned in environments that are noisy and ambiguous. This is often framed as a problem, but listeners continuously use unfolding speech to reduce ambiguity. Might such predictive processing support learning? If so, learning should be greater when the visual and linguistic context encourage prediction.

We tested this in a series of artificial language experiments examining the learning of gender-like affixes under ambiguity. Participants heard affix–noun pairs with two possible visual referents (target/foil), without feedback about which was correct. Affixes were associated with semantic cues (e.g., count nouns with “ma,” mass with “ta”). We compared languages where informative prefixes preceded nouns - meaning they could be used to anticipate and disambiguate the referent – with languages in which informative suffixes followed nouns, where such anticipation wasn’t possible.

Visual world eye-tracking confirmed that prefixes did facilitate anticipatory-looking. Also, critically, only prefixes supported successful generalization to novel nouns based on semantic- cues. Results were robust across different visual stimuli (vegetables with count/mass categories; novel objects with feature-based categories), different affix forms and stimuli with and without carrier phrases. These results are consistent with an account in which prediction facilitates learning and highlight the importance of linear order in language learnability.

[PS-2.15]

How does the statistical learning timeline change when sequences are different frequencies or when pauses are inserted into the stream?

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After exposure to a continuous stream of information in which sequences are embedded, frequently occurring sequences are recognized more readily than infrequent ones. Inserting pauses at sequence boundaries also boosts post-exposure recognition of sequences. Unfortunately, although these post-exposure effects indicate greater learning, it remains unclear whether that learning involves sequence parts or whole sequences. In this study, rather than focusing on post-exposure recognition, we examined time-course learning by comparing performance to control studies that varied in sequence length and composition (2, 3, and 4 item sequences and mixtures therein). Both frequency and pauses facilitated learning of sequence parts and of sequences themselves, with this learning being greater as the length of the sequence increased. Importantly, frequency had a greater influence on learning than placing pauses at sequence boundaries, supporting the huge effect that frequency has in other areas (e.g., language). To understand these effects, we implemented three prominent explanations of statistical learning (PARSER, SRNs, TRACX) – while none of these models matched the effects seen in human participants, PARSER provided the best explanation. Our studies show that frequency plays a large role in statistical learning, with no current explanations being able to account for all effects seen.

[PS-2.16]

Implicit Statistical Learning Through the Serial Reaction Time (SRT) Task: A Case of Multiple Regularities in the Sequence.

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For decades, research on implicit statistical learning (ISL) has often used a serial reaction time (SRT) task, measuring ISL by the change in reaction time between the sequence training and the random block. Although a variety of sequences are introduced in the training blocks, it remains unclear whether and how the statistical properties (probabilistic and deterministic) within a sequence influence ISL. This research investigated whether single versus multiple statistical regularities within a sequence affect ISL in 205 Indian children and adolescents (7–16 years).

In Study 1, a mixed-order condition (MOC) sequence containing both first-order and second-order probabilities was created to test learning of multiple regularities. Results from 120 participants showed no robust evidence of ISL for this complex MOC sequence. In Study 2, a single second-order condition (SOC) sequence was used to test ISL in 85 participants, and the results revealed significant ISL. These results demonstrate that sequence type critically affects ISL in the SRT task. Not all sequences in the SRT task are implicitly learned by children and adolescents, and learning is constrained when the input contains multiple, competing statistical regularities

[PS-2.17]

Individual Differences in Readers' Sensitivity to Multiword Frequency in Naturalistic Settings

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Multiword sequences (MWS) – frequently co-occurring word patterns – play an important role in language learning and processing. In reading, eye-tracking studies show that more frequent MWS are processed faster. However, previous studies have focused on specific types of MWS (e.g., formulaic expressions), and did not examine MWS frequency effects in ecological settings. Furthermore, it is unclear whether individual differences in reading skills relate to sensitivity to MWS frequency. We analyze eye-movement data from a naturalistic passage reading task (N=1204), from the Multilingual Eye-Movement Corpus English portion (MECO-L2). We examined whether trigram frequency impacts reading measures for the final word in the trigram, controlling for known covariates (unigram and bigram frequency, predictability, and length), and its interaction with individuals' reading skills. Trigram frequency significantly facilitated processing of the last word in the sequence across all examined reading measures. Importantly, we found that more proficient readers showed stronger MWS frequency effects, unlike the pattern for unigram frequency where more proficient readers show weaker effects. These results extend statistical learning views of reading, demonstrating that readers are sensitive to various regularities in the text, and that better readers leverage specific types of regularities to read more effectively.

[PS-2.18]

Investigating the role of the hippocampus in statistical learning in patients with temporal lobe epilepsy

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To date, there is still no clear consensus about whether the hippocampus plays a central role in statistical learning (SL). Some evidence implicates the hippocampus in SL, while other findings suggest that it may not be necessary. To address this question, we tested 23 patients with temporal lobe epilepsy (TLE), a group often characterized by broad hippocampal lesions (e.g., sclerosis) and memory impairments. TLE patients and age-matched controls listened to a continuous artificial speech stream composed of repeating trisyllabic words and were subsequently tested using both an implicit and an explicit measure of learning. The implicit measure assessed learning indirectly through reaction times, whereas the explicit measure required conscious familiarity judgements. Behaviourally, the TLE group showed comparable facilitation to controls on the implicit measure but performed significantly worse on the explicit measure, indicating a dissociation in the underlying neural mechanisms that support these processes. To further clarify the role of the hippocampus and its subfields, ongoing analyses of patients' high-resolution Magnetic Resonance Imaging scans focus on variations in hippocampal structure in relation to task performance. These preliminary results support that the hippocampus may contribute to the explicit but not implicit expression of statistically-learned knowledge, aligning with traditional neuropsychological models.

[PS-2.19]

Learning from cross-situational statistics under auditory dual-task load

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Cross-situational word learning (CSWL) is a statistical learning paradigm in which learners infer word–referent mappings by tracking cross-trial co-occurrence statistics across ambiguous episodes. Whether this form of learning depends on attention remains an important theoretical question for statistical learning research and the ecological validity of laboratory-based paradigms. Although attention has been widely debated in related paradigms (e.g., Dienes & Scott, 2005), its role in learning from cross-situational statistics remains poorly specified. Within CSWL, Roembke and McMurray (2021) found evidence that dual-task demands on verbal short-term memory can impair learning, suggesting that attention may gate access to cross-situational regularities. However, auditory dual-task load has not been tested.

We addressed this gap in a within-subjects study with 64 native speakers of Mandarin learning 16 Portuguese pseudowords (Ge et al., 2025). Participants completed a full-attention CSWL condition and a divided-attention CSWL+tone-counting condition, with items counterbalanced across conditions. Tone-counting accuracy was significantly lower than in a baseline task, confirming attentional load. Despite this, word-learning performance did not differ significantly between conditions: accuracy was above chance from the first block and improved across blocks in both. These findings suggest that learning from cross-situational statistics is robust to auditory distraction, refining attention-based accounts of CSWL.

[PS-2.20]

Linguistic statistical regularities affect infants' lexical processing commitment

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Infants are highly sensitive to statistical regularities in speech, but how these shape online lexical processing remains unclear. Using an infant-controlled gaze-contingent paradigm, we tested whether stronger adjective-noun bigram statistics increase infants' prediction speed for target nouns. Although they did not, they increased infants' choice commitment.

Twenty- to 22-month-old infants learned adjective-noun bigrams paired with animals. In a Deterministic condition, each adjective predicted one noun; in a Probabilistic condition, each predicted two nouns equally. Infants heard 6 bigrams (e.g., pretty doggy, happy kitty, little fishy/piggy, silly ducky/bunny) 6x each (36 exposure trials). At test, each trial began with two grayscale animals. After the adjective, a >250 ms target fixation triggered its label and turned it colorful; distractor looks triggered neither. Displays paired animals from Deterministic (doggy vs. kitty) or Probabilistic (fishy vs. ducky) bigrams. Each adjective was tested 4x (16 trials). Only one noun for each Probabilistic adjective appeared at test, ensuring a correct answer each trial. Animal assignment to conditions/sides was counterbalanced.

In 40 infants, statistical regularities did not affect target-triggering speed. However, infants in the Deterministic condition were more likely to maintain fixation after triggering, suggesting distributional regularity shapes confidence in online lexical processing.

[PS-2.21]

Modality Effects in Word Segmentation: Group-Level Similarities and Individual Differences

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Statistical learning (SL) is the ability to detect environmental regularities and extract structure from continuous input, enabling word segmentation through transitional probabilities. This study explored performance on a word segmentation task presented in visual and auditory modalities, in a sample of 27 undergraduate students. While previous research has compared SL across sensory modalities, we aim to examine whether differences in performance could be explained by individual perceptual and cognitive profiles, and whether group-level performance reflected a stable individual ability across modalities. Group-level analyses revealed learning in both modalities. However, individual analyses revealed different patterns: some participants improved performance from one modality to the other, others exhibited a decline, and a small subset showed stable performance with no meaningful differences between conditions. Mixed-effects regression models identified auditory and visual resolution, plus working memory as predictors of auditory SL. These same mechanisms also predicted visual SL, although their explanatory strength was reduced in this modality. Our findings suggest that modality effects are not uniform and confirm that group averages may obscure meaningful inter-individual variability. We discuss the crucial role of individual-level analyses in uncovering hidden patterns and deepening our understanding of statistical learning mechanisms.

[PS-2.22]

Neural entrainment reflects attention-dependent tracking of visual statistical structure

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Neural entrainment to structured regularities is often taken to reflect statistical learning. However, it is not entirely clear whether it necessarily leads to behavioral learning. One possibility is that entrainment indexes the initial perceptual tracking of structure rather than its encoding into long-term memory. If so, neural entrainment should be especially sensitive to endogenous attentional fluctuations. In a preregistered, within-subject study, 78 participants viewed streams of written syllables. These streams were either unstructured or contained statistical regularities based on a periodic distribution of frequent and infrequent syllables or on transitional probabilities (TP). Both forms of statistical regularity elicited robust neural entrainment, with TP-based structure eliciting significantly stronger responses than frequency-based structure. These effects emerged despite only modest behavioral evidence of learning. Critically, periods of greater attentional focus (indexed by low response-time variability during a concurrent categorization task) were positively associated with larger entrainment amplitude across individuals and greater phase consistency within individuals. These findings suggest that neural entrainment represents an attention-dependent stage in the perception of visual regularities. This stage may constitute a prerequisite perceptual mechanism for early structure detection, but may not, on its own, be sufficient to support longer-term learning.

[PS-2.23]

Neural Evidence for Rapid Statistical Learning from Natural Speech in an Unfamiliar Language

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Listening to speech is challenging: the acoustic signal is continuous and lacks clear boundaries between units such as phonemes, syllables, and words. Yet listeners effortlessly segment this stream into meaningful units, a process thought to rely, at least in part, on statistical learning. However, most research on statistical learning has relied on artificial or simplistic languages and coarse behavioral measures, leaving open the neural mechanisms underlying learning from natural speech. To address this, we recorded MEG signals from 35 Dutch listeners with no prior exposure to Mandarin as they passively listened to one hour of a Mandarin audiobook. Using a temporal response function approach, we examined how linguistic features modulated neural responses. First, brain responses were influenced by phonological similarity between Mandarin and Dutch, quantified with an automatic speech recognition model, suggesting that listeners mapped unfamiliar sounds onto native phoneme categories. Secondly, neural responses also reflected onset cues at multiple linguistic levels, from phonemes to words. Finally, listeners were sensitive to syllable frequency, indicating rapid implicit learning of distributional properties. Together, these findings suggest that during brief exposure to a new language, listeners leverage native-language representations while rapidly extracting statistical structure from unfamiliar speech.

[PS-2.24]

Obsessive-Compulsive Tendencies Modulate the Balance Between Statistical Learning and Cognitive Flexibility

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Theoretical models of Obsessive–Compulsive Disorder (OCD) emphasize that symptoms may arise from an imbalance between habitual and goal-directed processes, characterized by increased reliance on habitual behavior and reduced efficiency of goal-directed control. However, it remains unclear whether similar alterations appear at a more general, functional level, beyond reward-driven mechanisms. This study, therefore, investigated the relationship between statistical learning, an implicit, reward-independent mechanism that supports the acquisition of environmental regularities and the formation of habitual behaviors, and cognitive flexibility, a key component of goal-directed control, defined as the capacity to adapt behavior and cognitive strategies to changing environmental demands. By adopting a dimensional approach to obsessive-compulsive (OC) tendencies in a non-clinical sample, we aimed to clarify how continuous symptom variability relates to the interaction of these neurocognitive processes. A total of 404 participants completed an online probabilistic sequence learning task assessing statistical learning and a card-sorting task measuring cognitive flexibility. Results revealed an antagonistic relationship between statistical learning and cognitive flexibility, such that stronger statistical learning was associated with weaker cognitive flexibility. Importantly, this inverse association weakened as OC tendencies increased, suggesting that OC tendencies may alter the typical balance between automatic and goal-directed functions even at non-clinical levels.

[PS-2.25]

Online Hierarchical Network Dynamics Underlying Beat-Informed Non-Adjacent Dependency Learning

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Grammar acquisition requires linking elements separated in time, such as "has" and "-ed" in "has played". Such non-adjacent dependency (NAD) learning involves statistical learning (SL) to extract underlying regularities, yet carries greater complexity than adjacent SL. The quasi-rhythmicity of prosody may scaffold this process by capturing attention, as NAD learning is enhanced when dependent syllables coincide with beat positions (Franzoia & de Diego-Balaguer, 2025). Nonetheless, the neural networks subserving this enhancement remain unknown.

In this ongoing fMRI study using the INSIDEOUT framework (Deco et al., 2022), we characterize network dynamics during beat-boosted NAD learning in beat-aligned conditions. Given the key role of the motor network in rhythmic processing, we hypothesize a hierarchical cascade across motor, attentional, and language networks during learning. In a beat-misaligned control condition, engagement is expected to be driven primarily by temporal regions within the language network and, without rhythmic scaffolding, this condition should yield worse learning outcomes. Altogether, this study highlights the potential role of the motor system in rhythm-based scaffolding of grammar learning and, by probing familiarization rather than post-learning tests, proposes a novel approach to studying network dynamics during SL.

[PS-2.26]

Predictability in Production: Mandarin Classifier-Noun Selection and Optional Modification

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Language production requires speakers to constantly decide what to say and how to structure their message. These decisions are shaped by the distributional properties of linguistic elements: highly predictable content tends to be reduced (e.g., omission of optional words; Jaeger, 2010), whereas less predictable content is often elaborated to decrease uncertainty (Hoppe et al., 2025). We investigated how predictability (as measured by corpus-derived probabilities) influences multi-word selection and optional modification in Mandarin classifier-noun structures.

Using a cloze task, 90 native Mandarin speakers provided continuations containing classifier-noun combinations for low-constraint sentence fragments. Analysis revealed that production frequencies of the classifier-noun pairs were predicted by their corpus-derived probabilities, even when controlling for the individual word probabilities. Critically, participants were more likely to produce optional modifiers between classifiers and nouns when the classifier was less predictive of the noun (i.e., lower forward transitional probability) and when the noun was more frequent. This suggests that speakers add information to reduce uncertainty when a noun is less predictable, and to increase informativity when the content is relatively general, consistent with the idea that language users draw on their past language experiences during real-time production to flexibly manage uncertainty and informativity and achieve efficient communication.

[PS-2.27]

Prediction error in the processing of non-binary pronouns: is novelty more costly than redistribution?

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Non-binary pronouns (NBPs) have emerged from the need for accurate linguistic referencing of non-binary individuals. In English, the pronoun 'they' has been used, resulting in a change in its distributional patterns. In Brazilian Portuguese (BP), marked for grammatical gender, the pronoun 'elu' has been introduced. As both NBPs present higher processing costs than their binary counterparts, this study investigated whether the source of prediction error (i.e., novelty status or redistribution) modulates processing costs of NBPs by L1-BP L2-English speakers. We hypothesize that higher surprisal levels are observed in the novel NBP, due to higher unfamiliarity, and among more conservative individuals (cf. Gender/Sex Diversity Beliefs questionnaire). In a maze task, 42 participants read sentences presenting NBPs in L1-BP and L2-English. A linear mixed-effects model analysis of RTs showed no effects of source ($t=0.655$, $p=.51$) or L2 proficiency ($t=0.924$, $p=.36$), but an effect of conservativeness ($t=-3.179$, $p<.01$). Data suggests that pronoun introduction is not cognitively more costly than redistribution; conversely, personal indisposition towards non-binary genders seems to hamper processing. We argue that conservative individuals are less exposed to non-binary language due to less contact with this speaker community and that integration of NBPs in everyday language is hindered mostly by personal ideology.

[PS-2.28]

Rethinking forced-choice paradigms: Statistically induced chunking recall (SICR) as an assessment of statistical learning in autism

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Statistical learning (SL) is foundational to language acquisition and has been hypothesized to differ in autism, though findings are mixed. Forced-choice SL tasks rely on explicit judgments that may obscure subtle learning differences. In contrast, Statistically Induced Chunking Recall (SICR), tests learners' ability to verbally reproduce high- versus low-probability sequences following exposure to an artificial language. Autistic and neurotypical (NT) monolingual English-speaking adults (n = 25/group; ages 18–35), recruited via Prolific, completed a five-minute exposure followed by a spoken recall task including target and random syllable strings. Accuracy was scored at the syllable and trigram levels. Participants also completed the Autism Quotient (AQ). Both groups demonstrated better recall of high-probability syllables (AUT p= 0.02; NT p=0.05) and trigrams (AUT p= 0.02; NT p=0.05) relative to random strings. Contrary to predictions, there were no group differences in recall, and no associations between SICR performance and AQ scores, despite significant group AQ differences. Overall accuracy was lower than prior studies, likely reflecting methodological differences. These findings suggest broadly similar SL abilities in autistic and NT adults, with individual variability indicating that factors beyond autism, including online participation, may better explain performance. Data collection to assess in-person vs. online performance is ongoing.

[PS-2.29]

SemV: Words as Volumes in Semantic Space

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Historically, sense information for words is obtained via tremendous effort on the part of trained lexicographers: George Miller and colleagues' WordNet, which attempts to establish an ontology of meaning, is a well-known example. This "expert system" approach scales poorly and has idiosyncratic multilingual support. An alternative is corpus-based methods, of which SemD (Rogers and colleagues) is a relatively recent, successful example. However, because sense information is strongly indicated by context – i.e., because sentences in which bank=place you keep money and bank=side of a river would have little overall similarity, language models that create context-dependent word representations, like transformer architectures, should be mineable for word sense information. We introduce a new proposal, SemV (Semantic Volume), that uses entropy calculations on context-dependent word representations from large language models to obtain word sense information and can potentially distinguish polysemes from strict homonyms. We discuss the technical challenges and choices made when computing SemV, we compare SemV to other lexical variables (concreteness, frequency, etc.), and we use SemV to predict latencies in a concreteness task

[PS-2.30]

Sensitivity to Word Predictability in Naturalistic Reading: Individual Differences and Adaptive Tuning

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Writing systems are full of statistical regularities that readers rely on to process texts. Among them, word predictability (p(word|context)) robustly influences reading behaviour at the group-level. However, there are differing theories and mixed evidence on how sensitivity to word predictability relates to reading skill and language background (first (L1) vs. second (L2) language readers). Here we present two complementary studies examining (1) how readers differ in their reliance on word predictability, and (2) how readers adapt this reliance given its utility in a changing environment. Study 1 presents reanalyses of the Multilingual Eye-Movement Corpus (N=1,204 L1 and L2 English readers), modeling individual differences in predictability effects across eye-movement measures using Bayesian hierarchical models. We found that predictability effects were smaller among higher-skilled readers, while being larger in L1 than L2 readers after controlling for skill. Study 2, a pilot study, examines whether readers recalibrate their reading once the utility of word predictability changes. This is done by manipulating mean predictability of texts across blocks and modeling readers' reliance on word predictability and other regularities. Overall, we suggest that skilled reading involves not only assimilating statistical properties of the writing system but also dynamically adapting reliance on them in changing environments.

[PS-2.31]

Similar errors, different updating: a mechanistic account of developmental differences in statistical learning

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Developmental statistical learning (SL) studies report inconsistent age effects: age-invariance, increases, and decreases have all been observed depending on the paradigm. This heterogeneity may arise from age-related variation in the mechanisms underlying SL, how prediction errors are weighted and predictions are updated. However, little is known about how these mechanisms develop.

Here, we used an eye-tracking version of a probabilistic sequence learning task, the Alternating Serial Reaction Time (ASRT) task, to examine SL in adults and 8–13-year-old children (N=66). Anticipatory saccades were used to index trial-by-trial predictions and belief updating. We distinguished learning-dependent errors (reflecting accurate probabilistic knowledge) from not-learning-dependent errors (reflecting genuine model mismatch), and quantified switching versus staying behaviour triggered by errors.

Replicating prior ASRT findings, children showed superior SL. Importantly, while children updated their predictions more frequently, adults tended to perseverate in non-learning-dependent predictions, the impact of prediction errors was age-independent.

These findings suggest that children's benefit in statistical learning may arise from the dynamics of belief updating, suggesting a more exploratory updating strategy in childhood. These strategic differences may help explain prior mixed findings, as exploratory and perseverative strategies may not be equally advantageous across statistical learning paradigms.

[PS-2.32]

Speakers respond differently to statistical uncertainty about signals vs. messages

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It has been suggested that, much like prenominal adjectives, gender-marked articles help to enhance the statistical predictability of upcoming nouns. Supporting this idea, in a written paradigm Hoppe et al. (2025) showed that German speakers produced fewer prenominal adjectives than English speakers, but only when articles provided gender information (which English doesn't). We examined whether this pattern would replicate in a spoken paradigm, finding that in speech, prenominal adjectives were consistently produced across both informative and uninformative contexts. However, articulatory analyses revealed that in uninformative contexts, German speakers produced longer, more acoustically informative noun phrases at second mention than at first mention; in informative contexts, German production showed the opposite pattern. English speakers also exhibited this latter pattern. We discuss these results in terms of how uncertainty about signals and the messages they communicate influence articulation in different languages and contexts. These results indicate that whereas signal uncertainty (contextual support for the production of a word form) modulates the degree to which articulation is reduced, increases in message uncertainty (contextual support for the message being communicated) modulates the degree to which articulation is enhanced, with speakers behavior being driven by the statistical properties of the specific language being spoken.

[PS-2.33]

Statistical Learning and Word Segmentation in Norwegian Infants: No Evidence Across Dialectal Variability

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One of the earliest challenges in language acquisition is segmenting words from continuous speech. One mechanism supporting this process is statistical learning – ability to track distributional regularities in input (Saffran et al., 1996). Although this mechanism is well established in monolingual infants, its role under within-language variability (e.g., multiple dialect exposure) remains unclear. Norwegian is particularly relevant in this context, as it lacks a standardized spoken form and consists of a continuum of regional dialects differing in phonology, prosody, and grammar. This study examined whether 9-month-old Norwegian infants segment speech using statistical cues and whether bidialectal exposure influences performance. In a conceptual replication of Saffran et al. (1996), 91 infants (55 monodialectal, 36 bidialectal) were familiarized with an artificial speech stream containing four trisyllabic words defined by transitional probabilities. Segmentation was indexed by differences in looking times to familiar versus novel items using eye-tracking. Bayesian analyses indicated moderate evidence for the null hypothesis in both monodialectal (BF=0.20) and bidialectal (BF=0.18) infants, as well as for no group difference (BF=0.25). These findings provide no evidence of transitional-probability-based word segmentation in Norwegian infants at 9 months, regardless of dialectal exposure, pointing towards cross-linguistic differences in the onset of early statistical learning.

[PS-2.34]

Statistical learning defines which discourse biases guide pronoun interpretation

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Most research on statistical learning concerns small units like sounds, words, and sentences. We show that statistical learning also guides discourse-level processing. Several theories suggest that discourse-level predictions drive pronoun comprehension (e.g., Arnold, 2010; Rohde & Kehler, 2013) which may stem from frequency patterns in natural language. Johnson & Arnold (2023) showed that processing is biased toward recently encountered patterns, e.g. in "Ana ate with Liz. She…", people assign "she" to the second person more often if they recently saw many unambiguous examples of the second person (ObjPP) being rementioned (e.g., "Matt hiked with Ana. She…") compared to rementions of the first/ Subject ("Matt hiked with Ana. He…"). What mechanism guides reference adaptation? When exposure came from a context with "joint action" structure (e.g., X verbed with Y) it led to adaptation both for matching and transfer-verb test stories (e.g. X gave something to Y). But exposure to implicit causality contexts (X admired Y because…) only led to adaptation for similar test stories, and not joint action or transfer. This suggests that people track antecedents based on syntactic categories but not specific to semantic role. Three studies test the underlying mechanism and find support for frequency-tracking over a prediction-error mechanism.

[PS-2.35]

Statistical Learning of Grammar and Semantics in Adult L2 Acquisition: Evidence from Mandarin Classifier–Noun Combinations

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The central question of the present study is whether novice adult second language (L2) learners can acquire grammar-semantics mappings through an implicit training paradigm mimicking ambiguity in natural language contexts, and whether they show evidence of predictive processing during learning, defined as the anticipatory use of grammatical and semantic cues to predict upcoming information. Mandarin classifier-noun combinations (e.g., 四条领带 "four tiáo tie") provide insight into this question: pre-nominal classifiers are grammatically required and can semantically encode shape properties of following nouns.

In an ambiguous visual world paradigm, novice adult L2 Mandarin users (n = 28) were taught the classifiers 条 (tiáo; long shape) and 片 (piàn; flat shape). In each trial, participants viewed two images (one target, one foil) while listening to a classifier-noun combination (e.g., "Which four 条 (tiáo) are tie?") and had to click on the matching image without feedback (i.e., referential ambiguity). Eye-movements were recorded during training. They revealed that participants quickly reached ceiling-level in identifying nouns in real-time processing and they could use the classifier to predict the noun, even though the training was ambiguous. The post-test showed learning of the classifiers and generalisation of their shape-based semantics to novel nouns.

[PS-2.36]

Statistical learning of phonotactic probabilities through passive listening of a second language in adults

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Statistical learning research has largely relied on artificial languages, leaving open the question of whether similar mechanisms support learning in naturalistic contexts. Here, we tested whether passive exposure to a second language in adult learners facilitates sensitivity to phonotactic probabilities—how sounds in a language are combined. Participants passively listened to Italian podcasts (L2 exposure group) or English podcasts (control group) for three weeks and completed a word-rating task before and after exposure. Following exposure, only the L2 group demonstrated improved discrimination between words and nonwords at post-test, an effect not seen in the control group. Additional analyses revealed that the L2 group became sensitive to Italian phonotactic probabilities as well as word frequency information. These findings suggest that statistical learning mechanisms can operate in a natural language context to strengthen phonotactic representations, bridging laboratory-based artificial language findings with real-world language learning. Ongoing EEG analyses aim to test whether these behavioural changes are accompanied by neural changes during L2 processing.

[PS-2.37]

Statistical learning of syllable sequences and responses to violations: a joint MMN–ITPC EEG approach

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Language comprehension relies on prediction: listeners exploit learned regularities to anticipate upcoming speech. When expectations are violated, neural error signals are elicited, but the strength and functional consequences of these signals may depend jointly on (i) how predictable the violated element was and (ii) how large the acoustic deviation is. We propose an EEG study that systematically varies both factors to test predictive-coding accounts of speech sequence processing. Participants (N≈60) will listen to artificial syllable streams with three statistical structures: random (baseline), low-predictability triplets (within-word transitional probability ≈0.25), and high-predictability triplets (within-word transitional probability =1.0). Following exposure, test trials (12 syllables) will include one deviant replacing an expected word-medial or word-final syllable. Deviance magnitude will vary via MFCC Euclidean distance (small vs large). We will analyze mismatch negativity (MMN) and inter-trial phase coherence (ITPC). By jointly analyzing MMN and word-rate ITPC, we dissociate rapid, local prediction-error detection from broader, ongoing sequence-level learning/entrainment mechanisms. We predict stronger MMN and greater ITPC disruption for violations in highly predictable contexts, larger effects for larger acoustic deviations, and a predictability-by-deviation interaction whereby even small deviations elicit robust MMN when expectations are strong. Behavioral speeded target detection will provide convergent evidence of learning.

[PS-2.38]

The Association between Childhood Adversity and Statistical Learning Ability in Children: A Neuroimaging Study

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Socioeconomic status (SES) is a major determinant of environmental quality and childhood exposure to adversity. Research consistently links lower SES with low cognitive outcomes through both behavioral and neural pathways. However, little research has examined how adversity-related factors relate to children's statistical learning (SL) abilities. As part of an ongoing fMRI study, we report preliminary data from six children (M age = 9.33 years; additional participants will be recruited) during real-time learning of visual and auditory triplet tasks adapted from Schneider et al. (2020). Preliminary analyses indicate greater BOLD activation for structured versus random conditions during the visual SL task in the right lingual, angular, and supramarginal gyri, right precuneus, and bilateral occipital cortex. During the auditory SL task, increased activation was observed in the right middle temporal gyrus, anterior cingulate cortex, lateral occipital cortex, putamen, left supramarginal gyrus, and insula. Nonparametric analyses suggest strong associations between increased activation in the supramarginal gyrus and anterior cingulate cortex during auditory learning and lower household income and parental involvement. Similar patterns emerged in supramarginal gyrus and precuneus during visual learning, suggesting a "compensatory" neural effect associated with low SES. The results highlight the important links between adversity and neural mechanisms supporting SL.

[PS-2.39]

he cortical dynamics of 'statistical hearing'

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Listeners implicitly learn the probability distributions of sounds, and this learning can alter perceptual sensitivity even when those statistics are task-irrelevant. In recent behavioral experiments, our group has shown not only that listeners' detection of tone frequencies is driven by distributional statistics, but that detection sensitivity shifts dynamically with changes in statistical distributions. These data show that short-term sensory statistics profoundly shape auditory perception, and suggest an interplay of perceptual enhancement and, particularly, suppression. However, the neural dynamics and underlying mechanisms of these probability-dependent effects remain mysterious, as does the relative contribution and interaction between auditory- and auditory-associated areas. Here we investigate probability-dependent effects by having participants perform an auditory detection task where different low- and high-frequency pure tones were embedded in noise near individual detection thresholds. The relative probability of frequencies changed within runs.

In initial data (N=2) from an intensive, multi-session fMRI experiment, changes in relative frequency probability drove commensurate behavioral detection changes: when a frequency became more or less probable, detection accuracy accordingly increased or decreased. However, event-related fMRI responses were systematically lower for high-probability tones relative to low-probability tones. We will expand on these findings as ongoing data collection is completed.

[PS-2.40]

The interference of congruent and incongruent multimodal stimuli in statistical learning

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We can learn environmental stimulus patterns, which accelerate sensory processing. Unimodal statistical learning is well described; however, our environment is multimodal, requiring parallel processing. We aimed to observe the interaction of multimodal statistical information when presented simultaneously.

We recruited 138 healthy participants to learn an artificial language using visual and auditory syllable triplets presented in parallel. Participants were divided into five conditions based on the congruency of the modalities. As a control, auditory statistical information was presented with a random visual sequence. Learning was monitored through the reaction time of an unrelated detection task and through a familiarity post-test.

Parallel multimodal statistical information resulted in longer reaction time ($F(4,10989) = 106.88$, $p<0.001$) and lower familiarity test scores ($\chi 2=22$, $p<0.001$) compared to the sequence, where only auditory statistical information was presented with a random visual sequence.

These results show that learning effects were decreased when statistical information was presented both visually and auditorily. Here, we present that statistical learning in one modality can be disrupted by presenting parallel statistical information from another modality.

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[PS-2.41]

The Pace of Change: How the Schedule of Learning Conflicting Regularities Shapes Their Organization in Memory

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Our daily lives are saturated with regularities, but these regularities often change. Memory systems must therefore determine how to handle prior knowledge when new, conflicting information is encountered: should the old memory be discarded, modified to incorporate the new information, or preserved while an entirely new memory is formed? One potentially critical cue for this decision is the temporal structure with which the two regularities unfold. In the current study, we examined how different schedules of implicit associative learning shape the organization of memory representations following overnight consolidation. Participants completed a simple judgment task on a list of object images while undergoing eye tracking. Unbeknownst to them, the list contained regularities: certain objects (B and C) were always preceded by others (A), creating AB and AC pairs. These pairs were equally frequent, but conflicting: the same A predicted B in one location and C in another. Participants of the 'Interleaved' group saw AB and AC in an alternating fashion throughout the entire experiment. Participants in the 'Blocked' and 'Gradual' groups, however, saw AB predominately in the first half of the experiment and AC predominately in the last half. In the 'Blocked' schedule, AB was abruptly replaced by AC halfway through learning. In the 'Gradual' schedule, the transition was smooth: AB pairs became progressively rarer as AC pairs incrementally took their place. Using both implicit and explicit measures of memory collected one day later, we find that learning schedule had a marked effect on the organization of AB and AC memories. Results indicate that gradual transition between regularities facilitated their separation in memory, whereas an abrupt transition promoted their integration. These findings suggest that interference experienced during implicit statistical learning may drive memories apart, shedding new light on how the temporal structure of change in the environment affects such learning and the ensuing organization of implicit knowledge in long-term memory.

[PS-2.42]

Toddlers' grammatical knowledge influences predictive language processing

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A key feature of language processing is prediction; when listeners can correctly predict an upcoming word, language processing becomes more efficient. How do children learn to make these linguistic predictions? The current study examined whether toddlers (19- to 21-month-olds, N=36) can leverage sequential statistics in word sequences to make linguistic predictions. Toddlers were familiarized with two bigrams consisting of novel words followed by familiar nouns (e.g., sibu->fish, tulver->dog). At test, we measured toddlers' predictive processing based on anticipatory eye movements after hearing the novel words. That is, we determined whether toddlers looked to an image of a fish after hearing "sibu" but before hearing "fish" and looked to an image of a dog after hearing "tulver" but before hearing "dog."

On average, across the 8 test trials, toddlers did not show significant prediction. However, toddlers' prediction improved from block 1 (trials 1-4) to block 2 (trials 5-8) of test, $b=0.34$, $F(1, 192)=4.52$, $p=.035$. In particular, toddlers who were reported to combine words often on the MacArthur Bates Communicative Development Inventory improved the most, $b=0.45$, $F(1,191)=5.15$, $p=.02$. These results suggest that toddlers may be more attentive to sequential statistics in word sequences once they start combining words in their own speech.

[PS-2.43]

Unlocking the Secrets of Multilingualism: How Individual Differences in Implicit Statistical Learning Associate with Metalinguistic Skills and Reading in Indian Multilingual Children.

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Whether multilingualism confers cognitive advantages remains unresolved, particularly regarding how it shapes statistical learning (SL) mechanisms for language acquisition. While existing research has examined SL primarily in first and second-language acquisition contexts, its role in multilingual environments is underexplored. This study investigated individual differences in SL of single versus multiple regularities and their association with metalinguistic skills in multilingual children.

Forty-one bilingual and 40 multilingual children (aged 7–10 years) from India completed a Serial Reaction Time task under two conditions: a single second-order conditional (SOC) and a multiple mixed-order conditional (MOC) sequence. Metalinguistic awareness was measured by evaluating phonological awareness, morphosyntactic awareness, and reading proficiency in Kannada, Hindi, and English.

Linear mixed-effects analysis revealed a significant three-way interaction, indicating that SL performance varied by sequence type and language status. SL of the SOC sequence correlated significantly with metalinguistic skills only in the multilingual-multiliterate group. Positive correlations emerged with Kannada rhyme detection, word reading, and rapid automatized naming (RAN) accuracy, English morphosyntax awareness, and Hindi RAN accuracy, while a negative correlation was observed with Hindi RAN timing. These findings highlight language-specific associations between SL and metalinguistic skills, suggesting that SL mechanisms may support the acquisition of linguistic complexities in multilingual learners.

[PS-2.44]

When Predictions Falter but Movements Don't: Implicit Statistical Learning in Parkinson's Disease

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Atypical populations offer a powerful lens on typical cognitive architecture. Parkinson's disease (PD), characterised by dopaminergic degeneration in frontostriatal circuits, offers an informative model to investigate implicit statistical learning (ISL). However, findings on ISL in PD are mixed, partly because most paradigms rely on motor responses, confounding learning deficits with motor impairment.

We addressed this issue using a modified Serial Reaction Time task based on the language L generated by a Fibonacci artificial grammar, featuring some deterministic (01, 110) and some probabilistic (010, 011) transitions in the strings of L. Thirty-one individuals with PD were compared with 34 matched neurotypical controls and 32 younger adults. All were cognitively unimpaired (MoCA-screened). Beyond accuracy and reaction times, eye-tracking captured predictive fixations indexing anticipatory learning independent of motor output.

Reaction times were preserved in PD relative to matched controls, whereas younger adults were faster overall. In contrast, the PD group showed reduced accuracy, particularly in later phases. Critically, eye-tracking revealed diminished accuracy in predictive gaze behaviour in PD, indicating impaired anticipatory processing despite preserved motor execution.

A follow-up study will examine whether ISL prediction abilities correlate with striatal dopaminergic integrity (DaT-SPECT), evaluating ISL as a potential diagnostic marker in this clinical population.

[PS-3.1]

A unified mechanism of statistical learning? Evidence from cross-modal integration during learning

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Humans extract statistical regularities from the environment, also known as statistical learning (SL). Interestingly, it is still debated whether SL is tied to the modality in which learning occurred or whether there is a domain-general mechanism at play. The present study addressed this question by testing integration over two sensory modalities during SL. Participants completed a familiarization phase in which they were presented with auditory (faputilirafe) and visual (lotemumisapo) syllable streams, allowing for the extraction of embedded triplets (e.g., A: faputi; V: lotemu). Crucially, the syllables were presented in an interleaved manner, alternating between modalities: fa[lo]pu[te]ti[mu]li[mi]ra[sa]fe[po] (syllables in brackets were presented visually, the others auditorily). Results from a 2AFC test phase showed the usual pattern unimodally (e.g., statistically associated triplets were preferred to foils, both visual and acoustically). Critically, however, participants also preferred cross-modally associated triplets (e.g., falopu, lopute) vs. foils that did not follow the bimodal statistical structure. This suggests that SL does compute statistics cross-modally, which sheds new light on the important question of whether SL is a unified, domain-general mechanism. In ongoing work, we are using a novel neuroimaging technique, Rapid Invisible Frequency Tagging (RIFT), to identify the neural signatures of simultaneous multimodal SL and multimodal integration.

[PS-3.2]

Assessing neural signatures of statistical learning: A meta-analysis of EEG/MEG studies

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There is an ongoing debate on the limitations of behavioral measures of statistical learning (SL), including psychometric constraints and interpretive confounds in task designs. Neural measures, particularly EEG/MEG, offer a powerful alternative as they assess learning as it unfolds. Despite the growing use of these measures in SL research, no study has systematically evaluated their robustness. We are conducting a meta-analysis to examine the evidence for electrophysiological signatures of SL within the context of the segmentation paradigm (Saffran et al., 1996). Neural signatures selected for the meta-analysis include event-related potentials and magnetic fields, specifically N100(m) and N400(m), and pattern-rate entrainment. We aim to determine the robustness of these measures, identify moderators, and assess whether larger EEG/MEG effects are associated with larger behavioral effects. We also seek to evaluate the occurrence of publication bias in the literature. So far, 165 full-texts were selected for screening. Oscillatory power modulations, due to the limited number of studies, will be included in the literature review only. Crucially, this meta-analysis may shed light on current methodological challenges and point to new research directions.

[PS-3.3]

Benchmarking Long-Distance Statistical Learning in Simple Recurrent Networks

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Human statistical learning involves tracking both adjacent dependencies (e.g.,"barks" is a likely continuation of "the dog...") and long-distance dependencies (e.g., subject-verb agreement dictates "bark", not “barks”, as a continuation of "terriers, which are a type of dog, ..."). The mechanisms underlying such learning remain debated. Computational models such as simple recurrent networks (SRNs) offer frameworks for studying potential bases of statistical learning. Here, we investigate limits on SRNs' ability to acquire long-distance dependencies, providing a benchmark for exploring where human learning may diverge from the computations underlying learning in SRNs.

We created an artificial grammar where adjacent dependencies conflict with long-distance ones. These long-distance dependencies must be maintained across varying numbers of fillers (random sequences of X/Ys). SRNs with sufficient hidden nodes underwent a robust generalisation phase: they maintained predictions based on long-distance dependencies across much longer filler sequences than they were trained on. With additional exposure, SRNs attuned to the range of filler sequence lengths from training, but still maintained long-distance predictions over sequences approximately 50% longer than training fillers. These two characteristics provide new hypotheses about when human learners may show broad generalisation versus sequence-specific tuning.

[PS-3.4]

Beyond Word Familiarity: The Semantic Network Anchors Word Learning from Co-occurrence in Childhood

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Although children can track word co-occurrence regularities regardless of whether the words are familiar or novel, not all tracked information may be retained. Instead, prior knowledge may determine which regularities are retained and integrated, thus supporting acquisition of word meanings from word co-occurrence patterns. To test the assumption that known words serve as anchors for learning novel words, we examined whether the order in which informative co-occurrence regularities are experienced affects learning. 5-6- and 7-8-year-olds heard sentences in which novel words reliably co-occurred with familiar words in some sentences (e.g., foobly-apple) and with other novel words in others (e.g., foobly-mip). Overlap in context (e.g., foobly) implied semantic similarity (mip ~ apple). In the Anchored condition, children first heard novel words co-occurring with familiar words (foobly-apple), whereas in the Unanchored condition they first heard novel-novel pairs (foobly-mip). As we expected, children learned better in the Anchored condition. Surprisingly, this advantage was not due to a boost in learning novel-novel links after learning novel-familiar, but to blocking: learning novel-novel links first hindered subsequent learning of novel-familiar links. We propose an alternative account of "known words as anchors" that shifts the focus from word familiarity to words' connectedness within the semantic network.

[PS-3.5]

Capturing learning on the fly: an eye-tracking method to quantify prediction errors and updating the prior

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The ability to build predictive models of the environment drives adaptive behavior, yet the real-time dynamics of internal model formation and updating remain poorly understood. Conventional methods often rely on indirect, noisy measures, limiting insight into the fine-grained computational processes underlying learning. Here, we introduce a generalizable, gaze-based analytical framework that directly tracks trial-by-trial expectation formation and updating. Applied to an unsupervised probabilistic learning task, it dissociates prediction errors arising from environmental stochasticity but reflecting learning versus errors arising from inaccurate internal models; and quantifies how predictions are iteratively revised. Learners distinguished these error types: errors reflecting learning were more frequent and prompted fewer updates than errors reflecting insufficient knowledge. Participants also exhibited a strong bias to repeat their previous predictions, amplified when these predictions aligned with the underlying regularity. Crucially, updating depended more on the consistency of prior beliefs with task structure than on whether the predicted stimulus matched the presented stimulus. These results suggest that statistical learning may be less error-driven and rely more on conservative, stability-oriented updating, or on a Hebbian, repetition-based process. Our framework provides both a broadly applicable tool for quantifying real-time expectations and evidence for learning strategies that prioritize model stability in noisy environments.

[PS-3.6]

Categorical or scalar? Error-driven learning as a window on the nature of phonetic representations

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Models of error-driven predictive learning differ with respect to whether the predicted outcomes are assumed to be scalar (Rescorla-Wagner model) or categorical (logistic perceptron model). Scalar outcomes have an expected magnitude, while categorical ones have only a probability of occurrence. Because of this, the models differ in whether they predict overexpectation. In overexpectation, learners that experience A→X and B→X come to expect that AB→2X. Then, upon experiencing AB→X, learners' association weights for A→X and B→X decrease. Overexpectation requires an outcome (X) that has a magnitude. It is unknown whether humans show overexpectation in language learning, and there is a longstanding debate on whether phonetic outcomes are categorical. We therefore implement an overexpectation design with a phonetic outcome (high F0 or high amplitude). Learners hear a speaker react to creatures with a syllable [pi/bi], of ambiguous voicing. F0 is raised either at the beginning, where it is perceived as voicing, or in the middle of the vowel, where it is perceived as pitch. We also include a loudness manipulation that is clearly perceived as scalar. We find that overexpectation occurs in the two F0 conditions, but not in the loudness condition, suggesting categorical representation of F0 as both voicing and pitch.

[PS-3.7]

Dialogic reading enhances neural prediction of young children

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Dialogic reading (DR) is a form of interactive shared reading. Wang et al. (2022) found that shared reading experience in 12-month-old infants was associated with stronger occipital responses during unexpected visual-omission trials, an indicator of brain predictive signal. Yet, Wang et al.'s study did not account for infants' daily language experiences to this observed link. The current study addressed this gap.

Fifty-eight parents and their 12-month-old infants participated in a 5-minute shared book reading session. These sessions were recorded and coded into four DR strategies: prompt, evaluate, expand and repeat. Infant brain predictive signals were measured using fNIRS during unexpected visual-omission trials following brief audio-visual pair learning. Neural activation was indexed by the difference between HbO and HbR (HbDiff). Parents also used a Language Environment Analysis Pro digital language processor to estimate the number of adult-child conversational turns infants experienced in daily life.

HbDiff change of channel 4 significantly correlated with the DR-prompt score, while channel 10 significantly correlated with DR-evaluate score. After controlling for conversational turn counts, the link between channel 4 HbDiff and DR-prompt remains significant.

These findings suggest that parental use of DR strategies, especially prompting, is linked to infants' predictive brain signals beyond daily language experience.

[PS-3.8]

Distinct Neural Representations of Probability for Abstract and Item-Specific Information During Statistical Learning

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Encoding environmental probabilities supports the distinct memory formation for both abstract and item-specific information. However, the neural representations of probability across these two types of information remain unclear. The present study employed electroencephalography (EEG) to record participants' brain activity during a statistical learning experiment that dissociates abstract and item-specific information. They learned associations between pictures and artificial characters under high (100%), medium (50%), and low (0%) probability levels, along with a baseline condition without any statistical structure. Results showed that abstract and item-specific information resulted in different neural representations of probability, as indexed by both P200 amplitudes and beta band power. While item-specific information showed graded probability effects, abstract information demonstrated probability-invariant processing that reflected structural knowledge. In contrast, a late-stage P600 component indicated structural processing for both abstract and item-specific information. Representational similarity analysis further revealed that probability and structure are both encoded in the brain, with a cyclic pattern from structure representation to probability representation and back to structure representation. These findings suggest that the neural representation of probabilities is versatile and dynamic, shifting between probability-level or higher-order structural processing depending on whether information is abstract or item-specific and evolving over time.

[PS-3.9]

Does Domain-General Statistical Learning Predict Perceptual Learning for Non-Canonical Speech?

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Listeners adapt to non-canonical speech by updating cue-to-category mappings in response to systematic deviations in the acoustic signal (perceptual learning, PL). Because the statistical structure of these deviations modulate PL outcomes, PL can be conceptualized as a form of statistical inference. It remains unclear whether individual differences in PL for speech reflect domain-general statistical learning (SL) mechanisms or language-specific learning processes. Here, we test whether domain-general SL abilities predict PL of non-canonical speech.

To date, 19 participants (planned 60+) completed a serial reaction time task (SRTT), indexing domain-general SL. They then completed a speech PL paradigm (pretest, training, posttest), where PL is operationalized as improvement in intelligibility, quantified as percent words correct from pretest to posttest. Participants were exposed to either dysarthric speech or accented speech.

Regression results indicated evidence of PL in both conditions ($ps < .06$), demonstrating improved intelligibility following training. However, SRTT did not predict the magnitude of PL.

These preliminary findings suggest that adaptation to non-canonical speech may not be strongly constrained by domain-general sequence learning. However, the null relationship may reflect limited statistical power; completing data collection will ensure adequate statistical power to detect this relationship and assess whether the relationship differs by non-canonical speech type.

[PS-3.10]

Early response time Variability predicts Statistical Learning

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Response time variability (RTV) is widely used to index moment-to-moment fluctuations in attention during repetitive cognitive tasks, where lower variability is typically interpreted as sustained on-task focus. Despite its extensive use across tasks and populations, high RTV is usually framed as a marker of poor performance, and its potential functional role remains underexplored. Here, we examined two datasets collected from in-lab–tested healthy adults (N = 231) to determine whether RTV relates to learning on a widely used probabilistic sequence-learning task with second-order non-adjacent dependencies, the Alternating Serial Reaction Time task. We show that greater RTV early in the task predicted stronger statistical learning by the end of the session, and the effect persisted after controlling for confounds such as mean reaction time. This pattern aligns with evidence showing that statistical learning can benefit from reduced top-down attentional control, indicating that increased behavioral variability may reflect a task state that is less constrained and more conducive to extracting regularities. Ultimately, these findings highlight a more nuanced role of variability in cognitive processing, suggesting instead that elevated early RTV may serve as a behavioral signature of an open, computationally flexible state optimized for implicit pattern extraction.

[PS-3.11]

EEG frequency tagging reveals preserved statistical learning in preterm children aged 4–6 years

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Children born preterm, before 37 weeks of gestational age (GA), are at elevated risk for learning and language difficulties, yet their statistical learning (SL) abilities remain underexplored. We examined auditory SL in a total of 82 children aged 4–6 years, assigned to two preterm groups differing in degree of prematurity and one full-term group, using complementary neural and behavioral measures. During passive exposure to a continuous "alien" speech stream comprising four recurring trisyllabic pseudowords, EEG frequency tagging indexed online learning. Following exposure, children completed the Statistically Induced Chunking Recall (SICR) task as a behavioral measure of SL. Language abilities were assessed with the Dutch version of the Clinical Evaluation of Language Fundamentals Preschool-2 (CELF Preschool-2-NL). Both neural and behavioral measures revealed robust SL across all GA groups. Although prematurity was associated with lower language scores, SL ability did not mediate this relationship at the individual level. These findings suggest that SL abilities are preserved in preterm children and are unlikely to contribute to the language difficulties observed in this population. The results are discussed in light of the view of SL as a resilient capacity as well as the continued need for reliable SL measures, especially in developmental populations.

[PS-3.12]

Friends or Foes? The Interplay Between Statistical Learning and Executive Functions

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Human behavior relies on the interplay of automatic and controlled processes. Statistical learning (SL) is often considered an automatic mechanism supporting the extraction of environmental regularities, whereas executive functions (EFs) support controlled, goal-directed behavior. Yet their functional relationship remains unclear: they may operate independently, cooperatively, or competitively. We examined the association between SL and EFs in a large sample of young adults (N = 192) using multiple SL paradigms and a data-driven approach. Participants completed seven SL tasks, including online reaction-time measures and offline two-alternative forced-choice tests, along with a comprehensive EF battery. Factor analysis identified two EF components: a working memory–dominant EF factor and a verbal fluency factor. These latent factors were entered into a structural equation model predicting SL performance. The working memory–dominant EF factor was positively associated with performance on two-alternative forced-choice tasks and the Weather Prediction task, but showed a trend-level negative association with the Alternating Serial Reaction Time task, which captures learning online during continuous performance. Verbal fluency was unrelated to SL. These findings indicate that the EF–SL relationship depends on how learning is measured, with executive control supporting offline performance but potentially interfering with online learning processes.

[PS-3.13]

Harnessing implicit statistical knowledge to optimize reward-based decisions

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Statistical learning supports the implicit and automatic extraction of environmental regularities. However, it remains unclear whether previously acquired statistical knowledge can guide goal-directed, reward-based decisions when learning and decision making occur in separate contexts. We developed a two-phase paradigm (N = 78) that isolated statistical learning from its later application. In the first phase, participants performed a four-choice visuomotor task governed by a hidden probabilistic sequence without rewards. In the subsequent phase, decision trials were introduced in which four stimuli appeared simultaneously, and participants selected the rewarded option. Reward locations followed the same probabilistic sequence but were never explicitly indicated. Participants acquired statistical knowledge, showing faster and more accurate responses to predictable events. Critically, this knowledge transferred to decision making: choices exceeded chance level only when reward locations were predictable. Individuals expressing stronger statistical learning also showed better decision performance on predictable reward locations, indicating that the acquired internal model was recruited during choice. These findings demonstrate that implicitly acquired statistical representations can guide reward-based behavior. Statistical learning therefore provides functional priors that can be exploited when actions become consequential, supporting adaptive decision policies beyond perceptual and motor domains.

[PS-3.14]

Individual Differences in Adaptation and Error Minimization During Statistical Learning: A Webcam-Based Eye-Tracking Study

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Statistical learning can be governed by adaptation of high-probability inputs and error minimization triggered by low-probability inputs. To date, the contributions of memory and attention in these mechanisms remain unexplored. This study investigated how individual differences in implicit knowledge, explicit knowledge, mind wandering, and pattern awareness influenced adaptation and error minimization. One hundred and twenty-nine college students completed a visual statistical learning experiment while their eye movements were tracked using a webcam-based eye-tracker (WebGazer). In this task, visual cues predicted targets with either high (75%) or low (25%) transitional probability (TP). Gaze behaviors following high- and low-TP targets were recorded to measure adaptation and error minimization. Results reveal a negative association between adaptation (reduced looking at high-probable associations after high-TP targets) and implicit knowledge, which attenuated as learning progressed. In contrast, a positive association between explicit knowledge and error minimization (increased looking at high-probable associations after low-TP targets) emerged later in the learning process. By the last learning block, mind wandering significantly predicted adaptation, while pattern awareness predicted error minimization. These findings suggest an implicit-explicit dichotomy in adaptation-error minimization processes and demonstrate the feasibility of using webcam-based eye-tracking technology to investigate human learning and cognition.

[PS-3.15]

Individual Differences in Reading Comprehension are Related to Sensitivity to Predictability Effects During Connected Text Reading

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There is growing evidence that readers use statistical regularities in text - such as word co-occurrences and grammatical constraints - to predict upcoming words, enhancing reading comprehension (RC). However, relatively little research has examined individual differences in predictive processing, which we hypothesize are a major contributor to variability in comprehension performance.

In the current study, 45 undergraduates read 55 short paragraphs from the Provo Corpus, while eye movements were recorded and RC was assessed independently. Linear mixed-effects models examined lexical, semantic, and syntactic predictability as predictors of early (first fixation duration) and later (total fixation duration) processing. All predictability measures were related to eye movements and facilitated more efficient, i.e. faster, reading. Critically, RC moderated semantic predictability effects on first fixation duration: better comprehenders showed greater early facilitation for semantically predictable words than poorer comprehending peers. No RC interactions were observed for total fixation duration. This pattern suggests that skilled comprehenders use semantic information to help increase efficiency early in processing, while late processing measures appear to be less influenced by RC skill.

Together, these findings indicate that individual differences in RC are linked to readers' sensitivity to semantic statistical structure during naturalistic reading, especially during early processing.

[PS-3.16]

Investigating brain markers of visual statistical learning in school-aged children using magnetoencephalography frequency-tagged responses

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Statistical learning (SL) is typically assessed using post-exposure behavioral tasks administered after learning has occurred. Frequency-tagging approaches instead provide online neural indices of learning, have been applied from infancy to adulthood in the auditory domain, and recently to visual SL (VSL) in infancy. Whether this approach captures VSL in school-aged children, and whether these online neural measures relate to offline behavioral measures of VSL at that age, remains unexplored.

Participants aged 8-12 years (n=31) viewed a statistical stream of nine alien characters presented at 3.6 Hz and organized into fixed triplets (1.2 Hz) during magnetoencephalography (MEG) recording. Two post-exposure behavioral tasks were then administered to assess VSL.

Robust steady-state evoked potentials at the stimulus rate confirmed stimulus-driven visual processing throughout the task. Critically, a significant neural response also emerged at the triplet frequency over occipital regions, indicating that children's brains tracked the higher-order statistical structure of the stream. While behavioral data indicated triplet learning, preliminary analyses did not evidence any brain-behavior correlations, suggesting that these measures capture partially dissociable aspects of the learning process.

These findings demonstrate that MEG-based frequency tagging can capture online VSL in school-aged children, offering a promising tool for studying SL in developing populations.

[PS-3.17]

Language Experience Modulates the Statistical Learning of Speech With and Without Lexical Cues

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Successful speech comprehension requires listeners to segment continuous acoustic input into meaningful units. This process is supported by statistical learning of distributional regularities in the input and by prior lexical knowledge, yet how these mechanisms interact in bilingual populations remains poorly understood. The present study investigates how language experience modulates statistical learning during speech segmentation, with a particular focus on heritage Spanish speakers in the United States. Using an artificial language learning task, we examined whether a known lexical item facilitates statistical learning in listeners ranging in English–Spanish dominance. Heritage Spanish speakers from the western United States completed speech segmentation tasks in which artificial speech streams contained either statistical cues or both statistical cues and a known English word. Results revealed robust effects of language dominance: greater English dominance was associated with enhanced statistical learning across conditions, independent of the presence of a known word. Further analyses demonstrated that this effect was driven by relative age of acquisition of English versus Spanish, rather than language proficiency or use. These findings suggest that early language exposure shapes sensitivity to statistical and lexical cues in novel speech contexts, highlighting how bilingual experience modulates mechanisms of speech segmentation and word learning.

[PS-3.18]

Learning What Matters: Readers Adapt to Reliable Sources of Information to Resolve Print-Speech Uncertainty in an Opaque Writing System

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Reading proficiency involves the cumulative acquisition and effective use of the various statistical regularities embedded in one's writing system. Among these regularities, the most fundamental are the correspondences between letters and sounds. However, writing systems vary substantially in their print-speech uncertainty. We ask how readers adapt to their writing system's structure, learning to rely on specific sources of information that help resolve print-speech uncertainty, and how this reliance is tied to individual differences in emerging reading skills. To do so, we focus on Hebrew, a highly opaque writing system. We first present a corpus analysis, quantifying print-speech regularities using a novel whole-word consistency measure alongside common metrics of letter-to-sound mapping. Then, in analysis of a large-scale word recognition dataset (the Hebrew Lexicon Project), we show that Hebrew adult readers rely more on whole-word consistency and less on letter-to-sound uncertainty than English readers. Importantly, in a developmental study of N=300 primary-school children, we further show that better early Hebrew readers are those who rely more on whole-word consistency but less on letter-to-sound mappings. Together, these findings highlight the importance of quantifying language-specific statistical regularities and suggest that reading proficiency depends on adapting to the unique properties of one's writing system.

[PS-3.19]

MEG and EEG evidence for statistical learning from acoustic and abstract rhythms

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Statistical learning is based on different types of cues—some sensory, some abstract. Often, cues are intertwined, making it hard to reveal experimentally what is being learned and when. Here, in the auditory modality, we disentangle acoustic and statistical rhythms suitable for learning. To this end, we crafted artificial languages. In one MEG study, we dissociated the brain regions that track and integrate prosodic and statistical cues during artificial language learning. During learning, rhythmic cues induced neural synchronization at the rates of syllables (3.33 Hz) and pseudowords (1.11 Hz). On recall, prosodic and statistical learning was mirrored in M200 or M400 responses, respectively. Behaviourally, prosody supported learning of pseudowords. In addition, learned pseudowords were retained even after statistical cues were lost. These findings suggest that prosody and statistical cues jointly support language learning through endogenous modulations of neural synchronization. In a follow-up EEG study, we found that neural synchronization to pseudowords sustains after stimulus offset. Target pseudowords that are (mis)aligned with the pseudoword rhythm in terms of time (off-beat vs. on-beat), identity (deviant vs. standard), or both, modulated P2, N4, or P1 responses, respectively. Critically, the observed interaction effect points to an interdependence of when and what in statistical learning.

[PS-3.20]

Multilingualism and Statistical Learning

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Third-language acquisition research has observed a multilingual advantage in the acquisition of new languages. We propose that this advantage arises not only out of language knowledge and experience, but from cognitive-level differences in language learning. One candidate mechanism is statistical learning (SL). Although a small number of studies report positive associations between multilingual experience and SL, the enormous heterogeneity in both SL paradigms and in definitions of multilingualism makes it difficult to draw any firm conclusions.

The present study strengthens this literature by (1) employing a linguistic SL task that has previously been validated as a correlate of natural language learning ability and (2) treating multilingualism as a continuous measure, as opposed to defining discrete groups. Eighty adult participants from a range of language backgrounds will complete an artificial-language word segmentation task, their performance measured via statistically induced chunking recall (after Isbilen et al., 2020). Multilingual experience is then assessed with a detailed language background questionnaire (Li et al., 2020). We predict that higher language entropy scores-- reflecting more diverse and more frequent use of multiple languages across contexts-- will be associated with improved SL performance. Data collection is ongoing and will be finished by the time of the conference.

[PS-3.21]

Near-optimal auditory but suboptimal visual detection of temporal regularities

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Humans can detect regular patterns in modest-length auditory sequences, typically identifying them within around 1.5 cycles (i.e., 0.5 cycles beyond the first repetition). A comparison of this finding with an ideal observer suggests that this is near-optimal behaviour (for a 10 item-long regular pattern). We investigated whether this performance extends to vision. Participants (N=21) were presented with sequences of white dots. Each dot appeared for 50 ms in one of 20 positions. In random sequences, positions were sampled uniformly; in regular sequences, 10 positions were sampled randomly and repeated periodically. Participants required, on average, 2.5 cycles to detect transitions to regular patterns (in contrast to the 1.7 cycles observed in our replication of the previous auditory study). In a follow-up experiment (N=10), we explored regularity complexity by comparing 1D and 2D displays across three lengths of regular sequences: 5, 10, and 20 (with optimal performance at approximately 2, 1.5, 1.25 cycles, respectively). Human visual identification, however, required 2.5 to 3.5 cycles, indicating that while auditory regularity detection is near-optimal, visual detection is suboptimal and highly sensitive to pattern complexity.

[PS-3.22]

Readers' Sensitivity to Word-Length Combinations in Hebrew and English

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We tracked eye-movements during reading to uncover whether people differ in sensitivity to complex multi-word statistical patterns in a text, and how such differences influence their eye-movement efficiency – a key factor in good reading skills. We focused on sensitivity to the expected word-lengths of the four initial words in sentences in two contrasting languages, Hebrew and English. Using computational analyses of Hebrew and English corpora, we identified frequent and infrequent patterns of word-length combinations from sentence onset in both languages. Proficient readers' eye-movements were recorded while they read 200 sentences containing frequent or infrequent combinations, presented in randomized order. Eye-tracking measures included first fixation duration, gaze duration, skips and total reading time. Results in both languages will be outlined.

[PS-3.23]

Revisiting Statistical Learning in Transformer-Based Models

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Orhan et al. (2025) demonstrated a possible new computational basis for statistical learning using the transformer-based wav2vec2 model. wav2vec2 learns to process audio input by 'predicting' masked portions of audio using substantial preceding and following context (making its training 'non-causal', even though it was tested 'causally', with minimal future context). wav2vec2 showed human-like preferences in auditory paradigms (e.g., Saffran et al., 1998) with no further training. This provides a radically different candidate mechanism to assess as a potential basis for biological statistical learning (vs. prediction or chunking).

We assessed whether wav2vec2's ability comes from non-causal training, or other aspects of the transformer architecture, by training wav2vec2 from scratch strictly causally (temporally 'left-to-right'). The causal model performed similarly to the non-causal version, exhibiting robust detection of auditory structures in four distinct statistical paradigms. As with the non-causal model, results depended on whether models were trained on speech and/or music and/or environmental sounds. Thus, wav2vec2's success is not due to non-causal training. Next steps will focus on understanding mechanisms underlying causal wav2vec2 (e.g., by constraining attention) with the goal of critically evaluating whether on-the-fly, context-dependent inference without weight updates in transformer models is linkable to biological statistical learning.

[PS-3.24]

Rich Reader Phenotypes of Sensitivity to Language Statistics Explain Individual Differences and Tradeoffs in Reading

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Reading is increasingly conceptualized as a statistical learning process, where readers incidentally extract regularities from text. Recent studies show that individual differences in reading skill correlate with reliance on these regularities. However, extant studies have typically focused on a narrow set of patterns—a limited characterization of reading ability given the complex statistical structure of written languages. We propose a data-driven "reader phenotype" framework: multi-dimensional profiles reflecting how individuals are impacted by diverse statistical properties. We validated this approach by re-analyzing word-naming data from 486 children, using personalized statistical models to construct phenotypes from item-level behavior. Results show that rich phenotypes encompassing multiple properties explain substantially more variance in reading ability than models focused on common theory-driven properties. We then analyzed the geometric phenotype space to trace the sources of variance behind individual differences. Using Pareto optimality analysis, we identified distinct archetypes representing extremal reader profiles. These archetypes corroborate prior findings while suggesting new explanations for how trade-offs in sensitivity to statistical patterns shape the reading system, particularly highlighting differences among poorer readers. This framework demonstrates the capacity of high-dimensional phenotypes to model, predict, and explain individual variance in complex statistical environments, enabling further geometric analysis and application to other tasks.

[PS-3.25]

Same Sentences, Different Senses: How Input Modality Shapes Comprehension

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Previous research has shown that learners can use cross-situational statistics to acquire simple sentences, but this work has overwhelmingly focused on auditory input and comprehension-based outcomes. As a result, it remains unclear whether sentence learning through cross-situational exposure is modality-specific or modality-independent. We investigated whether input modality (auditory vs. orthographic) affects the cross-situational learning of simple sentences. During training, participants viewed two animated scenes and selected the scene that best matched an auditory or written sentence. Learning was assessed using a comprehension test in which participants judged whether single scenes matched sentences presented auditorily or orthographically. Participants trained in either modality showed reliable learning. Critically, performance did not differ as a function of training modality, and learners generalized fully across modalities: training in one modality conferred no advantage when tested in that same modality. These findings suggest that cross-situational learning supports modality-independent sentence learning, even when input is exclusively spoken or written. By demonstrating modality-general learning, this work extends prior research focused predominantly on auditory input and raises the question of whether such modality-independent learning also supports language production.

[PS-3.26]

Segmentation of an artificial language with conflicting statistical cues: Empirical and computational investigations

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Research shows that listeners exploit transitional probabilities (TPs) between successive syllables to segment continuous artificial speech into words. This learning has often been attributed to forward TPs (fTPs; probability that A is followed by B), until Perruchet and Desaulty (2008) demonstrated that backward TPs (bTPs; probability that A precedes B) are also informative. However, many studies confound TPs with syllable combination frequency, leaving unclear whether individuals rely on frequency, TPs, or both. We addressed this with an artificial language of bisyllabic words in which all syllables and multi-syllable chunks occurred equally often. The grammar made bTPs more informative (1.0 within words, 0.33 between) than fTPs (0.33 within, 1.0 between). Partwords had bTP 0.33, but fTP 1.0. Following exposure, participants chose between words and partwords. Subjects attuned to bTPs should choose words, while subjects attuned to fTPs should choose partwords. Adult participants (n = 55) primarily relied on fTPs ($p = 0.001$). Binomial tests showed that 27 participants robustly preferred partwords and 6 preferred words, while the rest performed within chance. In simulations with four models, simple recurrent networks and CIPAL attuned to fTPs, while PARSER and TRACX2 showed no preference. We will discuss theoretical implications.

[PS-3.27]

Statistical Learning Across the Lifespan: Dissociations between neural and behavioural markers

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Although widely studied, the relationship between statistical learning (SL) with age is still unclear. Neural signatures of SL have been demonstrated using Fast Periodic Visual Stimulation (FPVS) and EEG, but their behavioural counterparts also remain unclear. This work examines whether neural and behavioural indices of SL are related, and whether/how ageing modulates this connection.

Skilled readers were exposed to rapid streams of visual stimuli (words and pseudofont strings) divided into high- and low-frequency items. Neural responses were measured with frequency-domain EEG and learning was assessed with 2AFC behavioural tasks. Across an original study (N=41) and a conceptual replication (N=42), adults showed robust neural responses for high-frequency items, indicating neural grouping by frequency. However, behavioural performance was at chace at the group level.

A second study compared young (N=44,Mage=23) and older adults (N=57,Mage=68) using the same design, with the addition of a standard visual statistical learning (VSL) task. Older adults showed reduced neural responses (p=.01), with comparable behavioural performance. VSL task results differed between groups (p=.003) and declined with age (r=−.50,p=.0002). Overall, neural–behaviour correlations were weak, suggesting a dissociation between neural sensitivity and behaviour which highlights the multidimensional nature of statistical learning, whereby some components are affected by ageing.

[PS-3.28]

Statistical learning and abstract knowledge transfer in structured environments

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Statistical learning involves extracting regularities of token appearances, and inferring the underlying abstract structure governing pattern formation. In graph-learning tasks, this structure corresponds to the rules defining transitions within the graph. The acquired structural knowledge should enable transfer across environments sharing the same organization but differing in observable tokens. A key question is whether individuals who learn faster within graphs also show stronger transfer across graphs, or learning rate and transfer reflect independent components of behavior.

We reanalyzed the graph-learning dataset of Mark et al. (eLife, 2024), focusing on the graphs that shared hexagonal grid structure. Within days, graphs had identical structure but different tokens labeling the states, whereas across days they were variants of the grid structure. Accuracy across blocks within each graph was analyzed using a hierarchical Bayesian model separating baseline performance, within-graph learning, and graph-specific shifts.

Transfer appeared primarily as performance shifts across graphs rather than changes in learning rate. Shifts were largest across days, whereas within-day transitions were smaller and positively correlated across participants, suggesting stable individual differences in benefiting from prior experience with the exact same structure. Transfer effects overall showed little relation to learning rate, consistent with learning and transfer reflecting distinct behavioral components.

[PS-3.29]

Statistical learning and short-term memory of manual gestures: Evidence for stimulus-general and stimulus-specific processes

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Statistical learning (SL) of regularities embedded in manual gesture strings and short-term memory (STM) for gestures are under investigated aspects of cognition. To explore underlying mechanisms and the relationship between SL and STM of gestures, we developed tests of triplet segmentation, n-back, and serial recognition/recall for pseudo-signs (PS) and grooming gestures (GG). The results from college students with no prior sign language experience showed comparable and correlated SL performance of PS and GG stimuli, which did not correlate with their scores in IQ or conventional STM span tests. However, SL of PS selectively correlated with STM of PS, while SL of GG correlated with STM of both PS and GG. In addition, STM of PS correlated only with listening span, while STM of GG correlated with both listening and spatial (Corsi) spans, but not with visual patterns span. These findings suggest that a) SL of PS and GG might be supported by common mechanisms underlying manual STM and b) SL of both are related to verbal memory, while SL of (more familiar) GG is additionally supported by spatial memory. Further investigations with signers would inform us whether linguistic experience affects SL and STM of manual gestures.

[PS-3.30]

Statistical learning in language across multiple regularities: a micro-longitudinal study

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Statistical learning in language research has primarily focused on a single domain (e.g., phonological, distributional), and single-day timescales. However, natural languages are characterized by multidimensional statistical regularities, and protracted learning thought to be underpinned by multiple long-term memory mechanisms (e.g., Batterink et al., 2015; Mirković et al., 2019).

Here we present a micro-longitudinal study where adults were trained over four days on a large artificial language comprising statistical regularities across three domains (semantic, phonological, distributional). We assessed the learning and offline consolidation of arbitrary and systematic components of the language, as well as generalization of the statistical regularities to previously unseen items. We additionally manipulated the extent to which the regularities related to participants' existing knowledge. We used measures of implicit and explicit learning.

We observed: i) gradual emergence of the knowledge of systematic regularities resulting in stronger learning for regularities related to existing knowledge; ii) successful generalization of the systematic regularities to previously unseen items; iii) gradual emergence of explicit knowledge of the regularities which did not influence generalization. These findings will be discussed in the context of current models of learning and memory mechanisms that might underpin statistical language learning.

[PS-3.31]

Structure transfers, rules do not: Evidence from statistical learning across stimulus-response mappings

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Adaptive behaviour requires not only learning environmental regularities but also applying this knowledge in new contexts. Previous research suggests that statistical learning can transfer across tasks even when several parameters change. However, it remains unclear what exactly transfers: knowledge of a specific rule (e.g., a sequence) or knowledge of the underlying statistical structure that generates these regularities. To address this question, participants completed a two-session experiment separated by 24 hours. In both sessions, they performed statistical learning tasks with different stimulus–response mappings, allowing us to test which type of knowledge generalizes across perceptually different tasks. In the rule- transfer group (N = 62), participants encountered the same hidden sequence in both sessions. In the structure-transfer group (N = 61), participants learned different sequences while the statistical structure of the task remained the same. A control group (N = 60) encountered a sequence only in the second. Our results show that knowledge of the exact rule did not improve performance when the mapping changed. In contrast, the structure-transfer group learned more and at a faster rate than the control group. These suggest that transfer across stimulus–response mappings relies on abstract structural knowledge rather than knowledge of specific rules.

[PS-3.32]

Swap distance minimization shapes the order of subject, object and verb in languages of the world

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Languages of the world vary concerning the order of subject, object or verb. The most frequent dominant orders are SOV and SVO and models have been tailored to this fact. However, there are languages whose dominant order does not conform to these expectations or even lack a dominant order. The principle of swap distance minimization postulates that, within a language or an individual speaker, the average distance between orders in the space of permutations must be minimized. Orders that differ by a swap of adjacent constituents (e.g., SOV and SVO) are at distance 1 and by two swaps of adjacent constituents (e.g., SOV and VSO) are at distance 2. Preliminary evidence suggests that the principle shapes word order variation within languages, word order evolution and word order acceptability (Franco-Sanchez et al 2026, Ferrer-i-Cancho 2016, Ferrer-i-Cancho & Namboodiripad 2023). Here we take a step further and show that, across linguistic families and macroareas, word order variation is shaped by this principle even when the dominant order is not SOV/SVO or is lacking. Our findings have strong implications for how the human brain constrains the learning, production and processing of complex sequences like language.

[PS-3.33]

Tactile cues aligned with high-level linguistic features shape neural processing of speech in noise

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Language is multimodal, and the exploitation of diverse sensory information becomes fundamental especially in adverse listening conditions. Despite the beneficial role of visual cues is well established, little is known about haptic modality. This study examined whether temporally structured haptic cues can support speech-in-noise processing by modulating neural tracking of continuous speech.

Electroencephalography was recorded from 30 right-handed participants while listening to narratives presented as audio-only speech (A) in traffic or multi-talker noise, or as audio-tactile speech (AT) in multi-talker noise paired with vibrotactile stimulation at phoneme or word onsets. Speech comprehension and intelligibility were assessed, and neural synchronization with the speech envelope and tactile input was analyzed using univariate and multivariate Temporal Response Functions (mTRFs).

Although behavioral results did not differ significantly across conditions, neural tracking of the speech envelope showed earlier latencies in traffic than in multi-talker noise ($p<0.05$, cluster corrected). Importantly, vibrotactile stimulation significantly modulated neural tracking of target linguistic features (i.e., phoneme or word onsets; $p<0.05$, cluster corrected), although it did not enhance envelope tracking directly. Overall, the findings confirm the interfering impact of multi-talker noise and suggest that haptic cues aligned with salient linguistic features shape cortical dynamics during speech processing in challenging listening environments.

[PS-3.34]

The Alien Language Game: Investigating Modality Constraints on Statistical Learning in School-Aged Children

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Statistical learning (SL) extends across multiple stimulus modalities, but whether it is supported by a modality-general mechanism or modality-specific mechanism(s) is debated. Support for the modality-specific view comes from evidence of modality-specific constraints on learning, including differences in the effect of presentation rate on learning. Here, we investigated the developmental trajectory of rate-based constraints on visual and auditory SL in school-aged children. We tested 225 7- to 12-year-old children using a gamified SL task in both auditory and visual modalities at two presentation rates. In contrast with previous findings, auditory performance was not superior to visual at fast rates, nor was visual performance superior at slow rates. Moreover, performance in both the auditory and visual domains improved with age, with no interaction between age and modality. Thus, the present results expand our understanding of SL in school-aged children and provide evidence against two key predictions of modality-specific theories of SL.

[PS-3.35]

The Blueprint of Semantics: Zipf's Laws of Meaning and the Evolution of Semanticity in Catalan Language Acquisition

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This study explores the emergence of linguistic complexity by examining Zipf's Laws of Meaning and the evolution of semanticity in Catalan language acquisition. Using longitudinal corpora from the CHILDES database, we analyze child-adult interactions across five developmental stages, from early childhood (2 years) to late adolescence (18 years). The research aims to determine how the relationship between word frequency and polysemy matures as children progress toward adult-like linguistic patterns.

The results confirm that fundamental structural regularities—specifically Zipf's Law, the Brevity Law, and Heaps-Herdan's Law—are consistently present from the earliest stages of development. However, the focus of the analysis reveals a significant divergence in semantic organization: semantic regularities and the frequency-meaning correlation are notably weaker in younger speakers. This suggests that while children rapidly adopt the structural and statistical efficiency of language, their mastery of polysemy and the exploitation of meaning is developed more gradually. Furthermore, by applying a networked measure of semanticity, the study identifies a clear distinction between content and function words that persists throughout all age groups. These findings indicate that the child's lexicon is initially governed by statistical learning, while full semantic density evolves as a secondary, more complex layer of linguistic competence.

[PS-3.36]

The distributional statistics of acoustic and perceptual auditory dimensions affect sound detection

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Auditory systems learn the statistical structure of sensory input, with recent stimulus distributions shaping perceptual sensitivity. Prior work using a tone-in-noise detection task has shown that listeners implicitly learn task-irrelevant probability distributions of sounds, enhancing detection of high-probability tones while suppressing responses to low-probability ones. However, it remains unclear whether these effects operate on purely physical stimulus properties, or extend to perceptual dimensions such as pitch.

We examined this question across three experiments. In Experiment 1, we used missing-fundamental tones, which evoke a clear pitch despite lacking energy at the fundamental frequency. Exposure to a unimodal distribution produced robust enhancement for the high-probability pitch and suppression for neighbouring pitches, but effect size depended on whether the statistical manipulation occurred earlier or later in the task. Unlike effects previously observed with pure tones, these changes did not persist once the stimulus distribution returned to equiprobable. In Experiment 2, inharmonic tone complexes (degraded pitch coherence while preserving spectral content) showed substantial reduction in the statistical learning effect. In Experiment 3, spectral centroid varied while perceived pitch was held constant, revealing additional modulation driven primarily by spectral content. Together, the findings indicate that statistical learning can operate across multiple auditory dimensions.

[PS-3.37]

The Language of Mathematics: Can Statistical Learning also Predict Mathematical Development?

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Like language, mathematics is often described as a symbolic system governed by rule-based structures. In language research, statistical learning (SL), the ability to implicitly extract regularities from the environment, has been identified as a key mechanism supporting language acquisition. The role of SL in mathematical development remains, however, largely unexplored. Drawing on structural analogies between linguistic and mathematical knowledge, the present study provides the first large-scale, longitudinal investigation of the relation between SL and mathematical abilities. A sample of 167 secondary-school children was evaluated at two time points on auditory-verbal SL, curriculum-based mathematics performance, general intelligence, and several language measures. Cross-sectional analyses revealed significant correlations between SL and mathematics. Longitudinal cross-lagged analyses further showed that initial SL abilities predicted later mathematical performance. This pattern of results supports the view that SL may reflect a general learning mechanism that contributes to the acquisition of structured symbolic systems, including both language and mathematics.

[PS-3.38]

The role of feature predictability in modulating toddlers' word extension strategies

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When young children learn new object labels, how do they determine which features matter for word meaning? For example, when hearing the word "ball" while seeing a round, yellow, fuzzy tennis ball, how does a child decide whether "ball" refers to round things, yellow things, or fuzzy things? This study investigates whether toddlers use recent distributional statistics in their environment to guide their attention to object features during word learning. Specifically, we test whether 28- to 30-month-olds preferentially extend labels based on features that have been predictable in recent experience.

Toddlers are first familiarized with a sequence of novel objects ordered by color (e.g., pink, blue, pink, blue; Color Condition) or texture (e.g., fuzzy, spiky, fuzzy, spiky; Texture Condition). Two objects in the sequence are labeled with novel words. In subsequent extension trials, toddlers are asked to extend each label to a new object that matches the original either in color or in texture. Initial results from the Color Condition (N=36) show that toddlers preferentially extend by color. We predict that toddlers in the Texture Condition (in progress) will extend by texture. These findings would suggest that toddlers' recent experiences with predictable object features guide their word extension strategies.

[PS-3.39]

The Role of Perceptual Salience in Cross-Situational Learning

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Case markers are notoriously difficult to acquire in both natural and artificial languages, likely due to their low perceptual salience – being short, unstressed, and easily overlooked. This study investigates the role of perceptual salience in cross-situational statistical learning (CSL) of non-native morphology, focusing on agent and patient markers.

160 native English speakers with no prior exposure to Portuguese learned an artificial language modelled on Portuguese phonotactics. Case marker salience was manipulated via syllabicity, stress, and sonority (high: /-ˈka, -ˈʃi/; low: /-l, -r/). Participants matched spoken sentences to animated scenes depicting transitive actions. In training trials, scenes differed in at least two aspects (noun, adjective, verb, or agent–patient relation), providing multiple overlapping cues to track co-occurrences. In testing trials, they differed only in the target feature, e.g., verb test trials differed in the action. A subsequent grammaticality judgment task assessed sensitivity to morphosyntactic violations.

Participants successfully acquired verbs and nouns, but not adjectives or case markers. Only participants in the high-salience condition showed sensitivity to morphosyntactic violations, suggesting that perceptual salience enhances awareness of grammatical structure. These findings demonstrate the power and limits of CSL in L2 learning and highlight the importance of perceptual cues for acquiring complex grammatical structure.

[PS-3.40]

Tracking Patterns Across Languages: Statistical Learning in Bilingual Babbling

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Statistical learning offers a rich theoretical framework for how bilingual children track distributional probabilities across both of their languages (Antovich & Graf Estes, 2020). Whereas most research on vocal development has focused on the prelinguistic period, the early lexical stage—particularly persistent babbling—represents an unexplored window into emerging language-production mechanisms (Abreu et al., 2023). The current study investigates bilingual toddlers' babbling production during the emerging language stage (n = 23; 24-36 months). We asked: 1) How does the amount and distribution of adult bilingual input shape toddlers' babble? 2) To what extent does babbling reflect bilingual toddlers' consonant inventories and align with transitional probabilities in each language? 30-second segments were randomly selected from daylong audio recordings and coded for child production of Spanish, English, Code Switching and Babbling (Figure 1). Babbling clips were segmented using PRAAT and phonetically transcribed by trained human coders (Figure 2). We predict bilingual babbling will match the distributional aspects of caregiver input and may reflect established consonants in children's inventories and exploration of new sound combinations. Analysis is ongoing. Findings may enhance theoretical models that explain rule-based production of complex speech in more than one language, bridging early sound play and meaningful multilingual communication.

[PS-3.41]

Unraveling the impact of ADHD-like traits on the interplay between predictive processes and inhibitory control

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To navigate daily life successfully, we must adapt our behavior to environmental demands. This adaptability relies on a dynamic balance between goal-directed and automatic processes. In Attention-Deficit/Hyperactivity Disorder (ADHD) and individuals with ADHD-like traits, this balance is often disrupted, leading to a unique cognitive profile characterized by difficulties in suppressing irrelevant information and controlling impulsive actions. The competition hypothesis posits that because inhibitory control and statistical learning (SL) are antagonistic, the impaired inhibition among people with ADHD-like traits may drive a greater reliance on SL. To unravel this interplay along the ADHD-spectrum, we utilized a cognitive task combining implicit statistical learning with response inhibition in a non-clinical sample of university students (n=226). Our findings confirmed that higher ADHD-like traits are associated with poorer response inhibition. Most importantly, we found that ADHD-like traits shift the expected trade-off between statistical learning and cognitive control: it progressively disappeared as ADHD-like traits increased. These results suggest that ADHD-like traits influence cognitive functioning even below the clinical threshold by modifying how parallel processes interact. Furthermore, this research emphasizes that cognitive processes should be examined in parallel rather than in isolation, as their interaction can shift significantly along the ADHD spectrum.

[PS-3.42]

What Statistical Learning Does and Doesn't Learn

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Statistical learning (SL), despite typically being considered a domain-general mechanism, can be input selective. For instance, serial-presentation SL is more effective with auditory (or temporally unfolding) stimuli compared to visual stimuli. Furthermore, language may have co-evolved with SL in ways that make it more amenable to such learning than artificial stimuli (e.g. tones). Yet, no study has directly compared transitional-probability-based SL across different stimulus types. Here, we address this gap by assessing SL across different stimulus types with identical statistical patterns using a 2-AFC paradigm. In Experiment 1 (N=191), adults learned co-occurrence patterns most effectively in speech, less well in tones, and not at all in visual shapes, suggesting language may be especially amenable to SL. In Experiment 2 (ongoing, N=147), SL with non-linguistic human vocalizations (e.g., coughs, burps) was even more successful than with speech, suggesting SL advantages are not language specific. In addition, SL performance was worse with sign language stimuli, despite them being human-generated, linguistic, and unfolding over time. Future work will examine which aspects of human-generatedness drive this pattern (e.g., communicative intent), with the broader goal of identifying why some things are more readily learned than others.

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