

COGNITIVE SCIENCE AND TECHNOLOGY

Linguistics Study of Language

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Agenda & Contents

The Objective of this presentation is to layout a introductory understanding of how language and human interact in different medium through the Linguistic Approach

linguis·tics ^{lin-juh-siks}/LING'gwistik^s /LING'gwistik^s/the scientific study of language and its structure, including the study of morphology, syntax, phonetics, and semantics. Specific branches of linguistics include sociolinguistics, dialectology, psycholinguistics, computational linguistics, historical-comparative linguistics, and applied linguistics.

01 The Nature of Language

02 Language Acquistion

03 Cognition and linguistics

05 The linguistics Approach

06 Tesler's Law

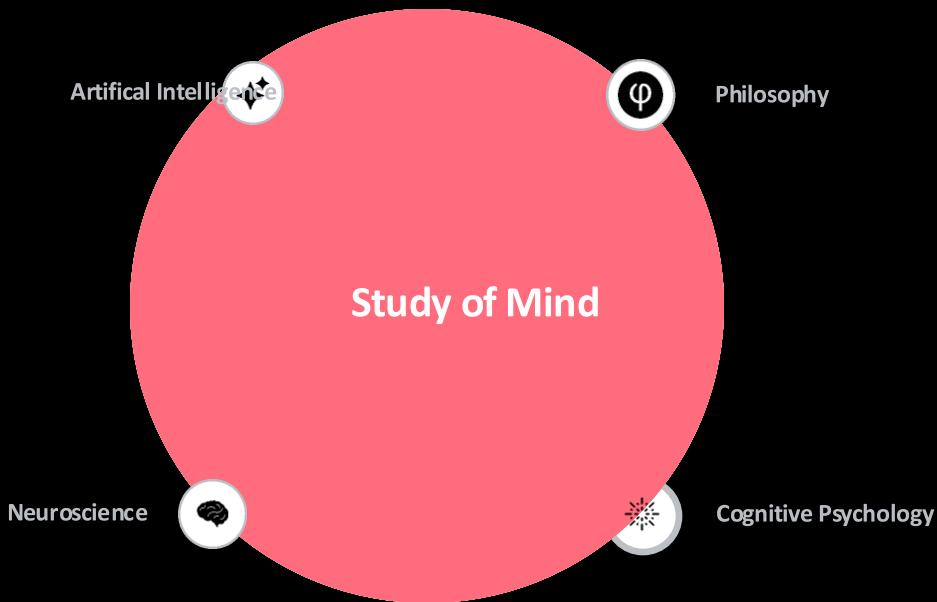
07 Key takeaways and Conclusion

WHAT MAKES LINGUISTICS UNIQUE WITHIN COGNITIVE SCIENCE

**“How very commonly we hear it remarked that such
and such thoughts are beyond the compass of words!
*I do not believe that any thought, properly so called, is
out of the reach of language.*” —Edgar Allan Poe, 1846**



LANGUAGE + COGNITIVE SCIENCE

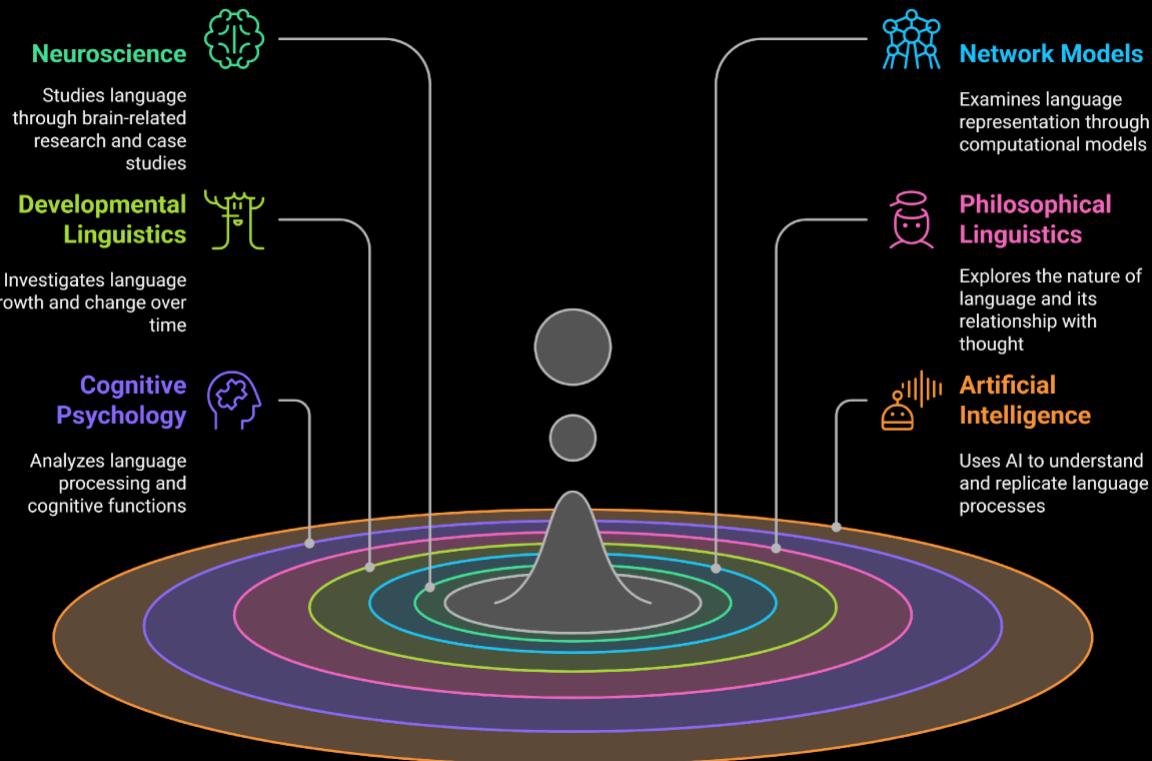


Understanding mind through use of linguistics

Linguistics is broadly defined as the study of language. It encompasses a wide range of investigations into the nature of language, its structure, how it is acquired, how it is used in communication, and its relationship to thought and the brain. Rather than being defined by a single methodology or theoretical stance, **linguistics is united by its focus on language itself as the subject matter**.

COGNITIVE SCIENCE + LINGUISTICS

Interdisciplinary Linguistic Studies



The Nature of Language



Philosophy

The philosophy of mind, a branch of metaphysics, directly engages with questions about the nature of mental phenomena, including language.



Linguistics

Focuses on language as the subject matter of investigation, rather than a specific perspective or methodology



Sapir-Whorf Hypothesis

Structure of a language determines a native speaker's perception and categorization of experience.



Characteristics of Language

Enables interaction and information exchange between individuals.

Eg. Two Friends taking to each other about school

Communicative 

Information Production
Transmission
Comprehension

Allows for the creation of new meanings and sentences.

Eg. A speaker can create never heard before sentences like ,The purple unicorn flew over the sparkly rainbow while singing opera

Generative 

Sentence Creation
Meaning Expansion

Evolves with the addition of new words and rules.

Eg. The introduction of new words like 'selfie' or changes in the usage of existing words over time

Dynamic 

New Words
Grammar Changes

Symbols in language are not inherently linked to their meanings.

Eg. The word "tree" in English , "arbre" in French all refer to the same concept but different unrelated sounds and spellings

AD  Arbitrary

Symbolic Elements
Referential Nature

Structured 

Rule-Based Ordering
Language Variations

Governed by rules that dictate symbol arrangement.

Eg. The sentence "The dog chased the ball" is grammatically correct, while "Dog the ball chased the" is not demonstrating the importance of syntax

The Importance of Language



Language Deprivation

Language deprivation, the absence of exposure to language during crucial developmental periods, can lead to severe and lasting impairments in language acquisition, highlighting the existence of a critical period for language development



Evaluation language Deprivation

Studies of language-deprived individuals provide valuable insights into the necessity of environmental input for natural language mechanisms, their generalisability is limited due to the small sample sizes and often unknown pre-deprivation histories



Language Acquisition



1

Language in Primates

Examining whether animals possess genuine language abilities.

Studies using sign language and lexigrams (geometric symbols) with primates are discussed and evaluated to understand the extent of their linguistic capabilities

Washoe, a chimpanzee who learned a significant number of American Sign Language signs and could combine them to form simple sentences

Kanzi, a bonobo who learned to communicate using lexigrams (geometric symbols) and demonstrated comprehension of spoken English



Language Acquisition

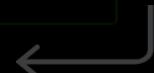


Evaluating language Acquisition

Human Language developmental stages like babbling and the one-word stage, as well as theoretical debates surrounding the nature versus learned aspects of language

Behaviourist theories, as outlined by Skinner, proposed that language is learned through environmental reinforcement, with children being rewarded for correct utterances

Chomsky's theory of universal grammar and the challenges posed by Gold's paradox highlight the likelihood of innate constraints guiding language learning.



The linguistics Approach

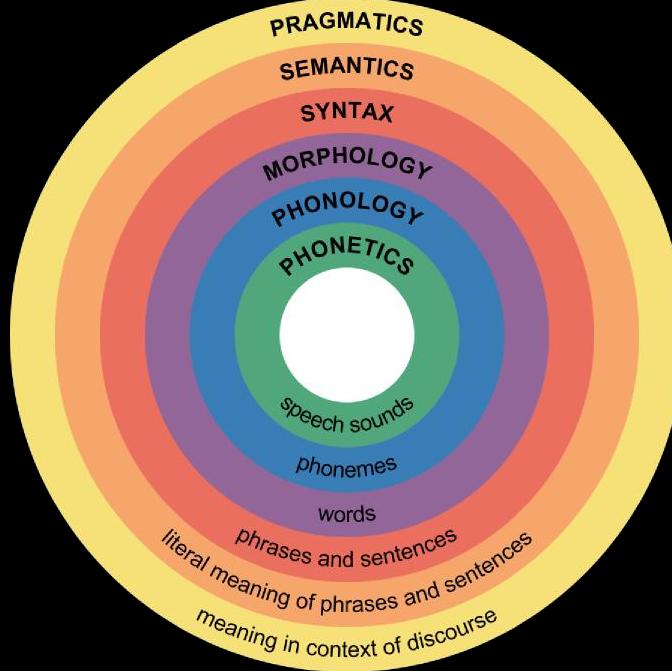


1

Cognitive and linguistics

The rise of cognitive psychology was partly due to its ability to offer better explanations for language acquisition than behaviourism

Mind as Information processor language is a key domain through which information is encoded, processed, and communicated



Different branches of linguistics might adopt various methodological approaches, including **experiments, computer modelling, the study of brain-damaged patients, developmental tracking, and cross-linguistic comparisons**



The linguistics Approach

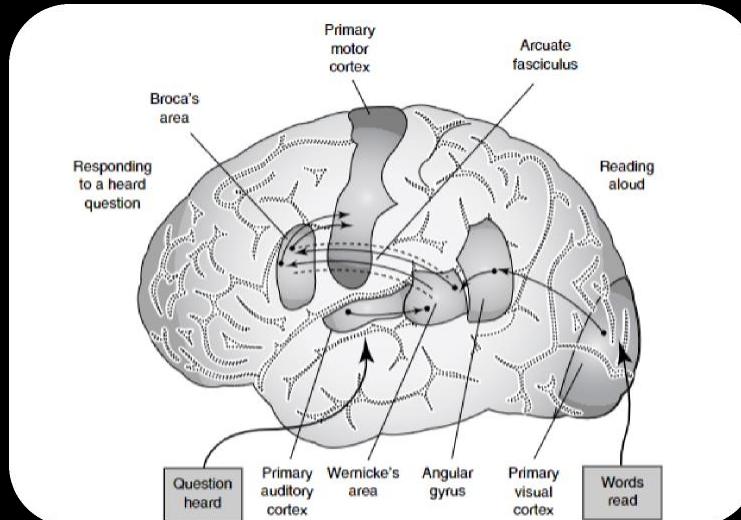


2

Neuroscience and linguistics

The intersection of neuroscience and linguistics has led to the field of cognitive neuroscience (or neuropsychology) which aims to understand the neural basis of language functions

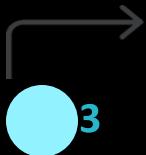
Neuroscience methodologies, such as studying brain-damaged patients and using brain imaging techniques (PET, CAT, MRI), are employed to investigate the brain regions involved in language processing



The **Wernicke-Geschwind model** is a classic neurobiological model that maps language comprehension to Wernicke's area and language production to Broca's area(left frontal-lobe of brain), along with their neural connections



The linguistics Approach



Artificial Intelligence

Natural Language Processing (NLP) is a subfield of AI dedicated to enabling computers to understand, interpret, and generate human language

Computational modelling is a shared technique between AI and cognitive psychology in studying language processes

Natural Language Processing (NLP)

NLP include speech recognition (converting spoken language to text), syntactic analysis (parsing sentence structure), semantic analysis (understanding meaning), and pragmatic analysis (interpreting language in context)

AI methodologies in NLP can be top-down (based on abstract rules and logical processes) or bottom-up (using neural network models to learn from data)

Computational Modelling

AI systems aim to achieve natural language understanding and generation, which are the computer equivalents of human language comprehension and production

Challenges remain in dealing with the inherent ambiguity and complexity of natural language, requiring extensive knowledge of the world and social context



The linguistics Approach in Google AI



3

Language & Artificial Intelligence

Google uses NLP to understand and generate human language, enabling features

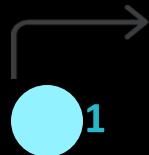
Developing Products with translation, speech recognition, and natural language processing, with a focus on expanding language technology and supporting diverse languages.

Such as , Multilingual AI , Conversational AI etc..



Source: <https://cloud.google.com/natural-language>

In-depth : Logogen Representation and Sensory Activation

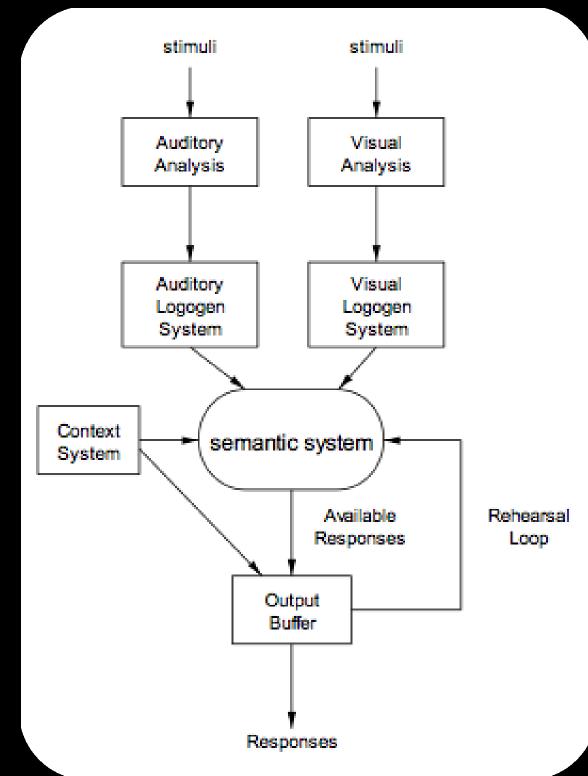


Logogen model

The logogen model posits that for every word a person knows, there is a corresponding logogen, which is a word representation

These logogens are stored within a lexicon, a mental dictionary, and the model originally proposed two separate input lexicons: one for auditory word representations and another for orthographic (visual) word representations

Eg. if you see "p" in the context of "a writing utensil," the logogen for "pen" will be activated more strongly than the logogen for "parrot".



Categorization of Linguistic Utterances

**Turn down
the radio**

The directive clearly instructs an immediate action.



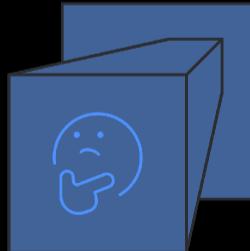
**It is hot in
here**

The assertion implies a need for environmental adjustment.



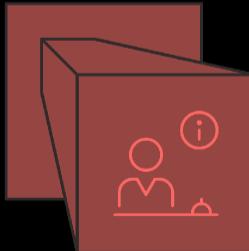
**I apologize
for yelling at
you**

The speaker expresses regret and seeks to maintain trust.



**You are
hired**

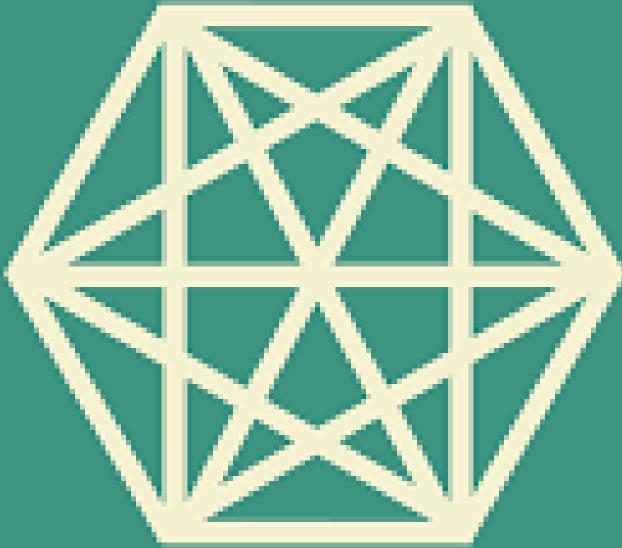
The statement directly commands a significant change in status.



Play : Conversational Pragmatics tools

The screenshot shows the homepage of the Quick Draw! game. At the top left is a pink button with a white question mark icon. At the top right are social sharing icons for Twitter and Facebook. The center features a banner with the text "QUICK, DRAW!" above a hand-drawn illustration of a hand pointing at a pizza slice. Below the illustration are various small doodles including a bicycle, a cup, a key, and a flower. The main text on the page reads "Can a neural network learn to recognize doodling? Help teach it by adding your drawings to the [world's largest doodling data set](#), shared publicly to help with machine learning research." A large yellow button at the bottom center says "Let's Draw!". At the bottom left, there are links for "This is an AI Experiment" and "Made with some friends from Google". At the bottom right, there is a language selection dropdown set to "English" and links for "Privacy & Terms".

Source: <https://quickdraw.withgoogle.com/>



Tesler's law

TESLER'S LAW

Tesler's Law, also known as The Law of Conservation of Complexity, states that for any system there is a certain amount of complexity which cannot be reduced.

source : <https://lawsofux.com/teslers-law/>



TESLER'S LAW ORIGINS

The origins of Tesler's law can be traced back to the mid-1980s, when Larry Tesler, a computer scientist at Xerox PARC, was helping to ***develop the language of interaction design***

a set of principles, standards, and best practices for defining the structure and behavior of interactive systems

Every application must have an inherent amount of irreducible complexity. The only question is who will have to deal with it.

—Larry Tesler

source : <https://lawsofux.com/teslers-law/>

TESLER'S LAW - COMPLEXITY BIAS

**The more complexity and assumptions
a solution has, the greater the chance
of failure.**

source : <https://lawsofux.com/teslers-law/>



TESLER'S LAW

**Who should bear the burden of complexity
within an application or a process— the user,
or the designers and developers?**

source : <https://medium.com/kubo/teslers-law-designing-for-inevitable-complexity-43e07d457f65>



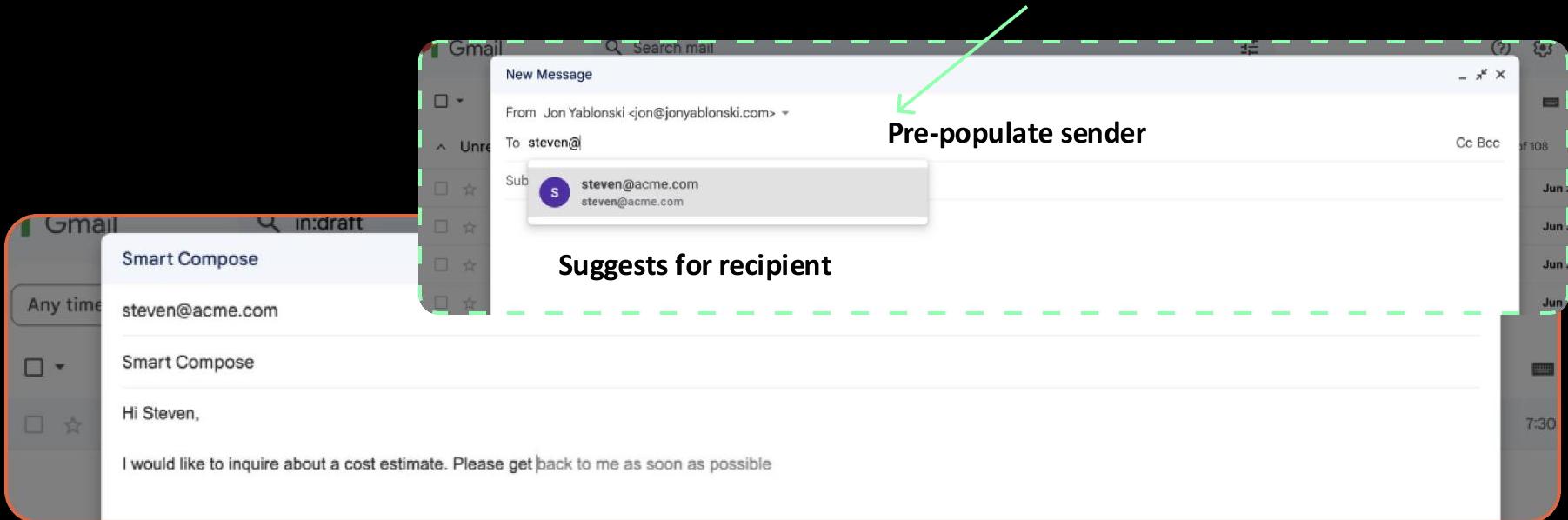
TESLER'S LAW

Tesler reasoned that “if a million users each waste a minute a day dealing with complexity that an engineer could have eliminated in a week by making the software a little more complex, you are penalizing the user to make the engineer’s job easier.

source : <https://medium.com/kubo/teslers-law-designing-for-inevitable-complexity-43e07d457f65>

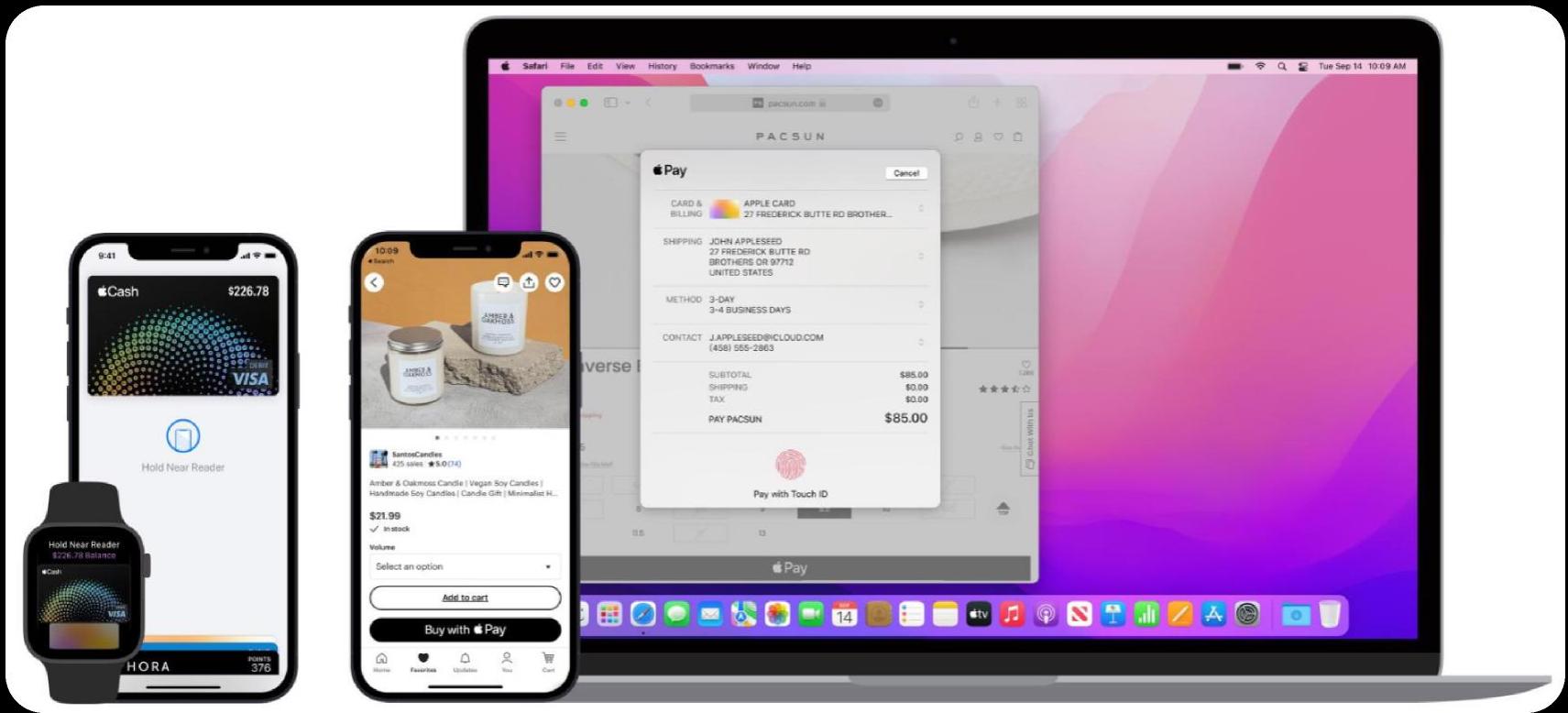


User Experience Design



Gmail now leverages artificial intelligence (AI) within your emails through a feature called Smart Compose

source : <https://lawsofux.com/articles/2024/teslers-law/>



Apple Pay makes the checkout process as easy as selecting the payment option and verifying your purchase

source : <https://lawsofux.com/articles/2024/teslers-law/>



Amazon Go retail store in Seattle - Checkout-free shopping experience
by abstracting complexity from users

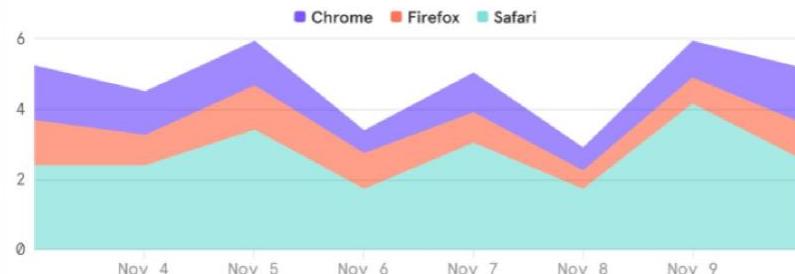
source : <https://lawsofux.com/articles/2024/teslers-law/>



mixpanel

Conversion rate over time by browser

Uniques, Past 90 days



Show conversion rate by browser ⌂ ⓘ

Slice your data with another text prompt

Generate

Save

Mixpanel - a product analysis software, which enables users to conduct in-depth analyses of data by simply asking questions in natural language

source : <https://lawsofux.com/articles/2024/teslers-law/>

TESLER'S LAW

The complexity isn't entirely gone; it's just abstracted away to reduce the effort required of the user.

source: <https://lawsofux.com/teslers-law/>



Q&A /
Discussions

Thank You