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Linguistic and Philosophical Investigations

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Externalizing Inputs with Ostension Schemes

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ABSTRACT. In this paper, I explore theoretical foundations for an instrument I have developed for the monolingual elicitation of natural language and for its ostension, allowing me to approach core issues in linguistic and the philosophy of language in practical and concrete terms (Werner and Olesova, 2015; Werner, 2017). Monolingual elicitation of natural language, as well as its ostension, necessarily couples linguistic utterances with information flow, given the arbitrariness of the linguistic sign. The instrument I have been developing for these purposes, the ostension scheme, couples sentences from a target language with information flow along multiple channels. Ostension schemes are matrices, with each row (introduced by a picture) representing a channel of information and each column (headed by an elicited sentence) representing information shared across channels. Each column therefore externalizes the input for the sentence which heads it. Linguistic meaning is what connects forms within the sentence with information in the input, rendering the basic sentence as the unit of information in language. Because ostension schemes externalize the input of an utterance, the meaning of the utterance can be recovered. Similar sentences can be compared, helping to identify individual parts and their meaning. The account of interaction between information and linguistic meaning generalizes to an explanation of veridical sentences and fictitious ones. These sentence varieties will be argued to have similar inputs, the difference in status coming down to the value assigned to a source variable in the input. The source variable is constrained by the linguistic forms. If that variable has an actual value, the sentence is rendered true or false. If the value is virtual, the sentence is merely fictitious. With no value for the source variable at all, the sentence appears under mention. Sentences elicited for ostension schemes are a special case of sentences under mention, made especially transparent given their placement within the scheme. In this way, the practical issues of monolingual elicitation and ostension of natural language offer new perspectives on certain longstanding foundational issues.

Keywords: ostension; monolingual elicitation; linguistic meaning; information flow; arbitrariness of linguistic sign

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1. Introduction

1.1 Preview

I would like to begin by qualifying theoretical claims in this paper with respect to the antecedent literature. Over the course of this paper, I touch on authors from several fields who have left an indelible mark on the subject of ostension and elicitation. These authors help motivate aspects of my proposal, even though in no case do I follow any author to their same ultimate conclusion. My goal is the development of a practical instrument, and this does force me to address certain foundational issues for which I have turned to past authorities in various fields. The vantage points of these selected authorities help clarify underlying difficulties concerning elicitation and ostension of natural language. The overlap, and the points of difference, between these vantage points is revealing. I admit to having focused largely on earlier literature and no attempt is made here to review all relevant literature or to cover recent developments in ostension or fieldwork. My intention is not to compete with up-to-date specialist accounts but rather to explain the practical instrument I am developing – the ostension scheme. For this, it has been helpful to see the underlying issues in their starkest form and one that connects to some of the earliest ideas in ostension. My discussion begins with Leonard Bloomfield, who introduces the procedure of peeling out words through comparison of simple, translated sentences. Since I wish to forgo translation, however, I am led to difficulties famously raised by Quine. Ostension schemes do provide a solution to the easiest of these, a solution that seems to have been anticipated by Quine himself. A comparison with Wittgenstein, who ultimately distrusts ostension, helps bring out a critical point implicitly accepted by Bloomfield and Quine – that ostension is fundamentally over sentences rather than over individual words. That requirement supports the thesis that the declarative sentence is the unit of information in language. The declarative sentence is the target of elicitation and ostension since these activities involve manipulations of the flow of information. It is in these terms that I will explain ostension schemes with my basic account of information flow due to Dretske. But going beyond Dretske, I present ostension schemes as a device to externalize the input of a sentence and to facilitate the manipulation of such input. This requires understanding information in a way that makes sense of inputs. Recent developments in Optimality Theory (OT) cast sentence inputs in cognitive or non-linguistic terms, and therefore I borrow from this theory a basic framework, even as I depart from standard assumptions of OT in significant ways. My discussion in this way draws of a variety of sources without showing absolute allegiance to any of them. My stated aim is not to imply that I have solved foundational theoretical issues. My hope is to have taken preliminary steps towards overcoming certain practical difficulties and to have elucidated certain theoretical issues along the way.

1.2 Early approaches to ostension

In his *Outline Guide to the Practical Study of Foreign Languages*, Leonard Bloomfield (1942: 10–12) discusses ways for a linguist to approach an unknown foreign language with the cooperation of a native speaker of that language. Bloomfield suggests that after eliciting words for basic concrete objects, the linguist ask the consultant for translations of concrete, unambiguous sentences into the target language. These translated sentences provide the basis for discovering smaller grammatical pieces, words and inflectional morphemes. Isolating words and inflectional morphemes from their larger syntactic context Bloomfield refers to as *peeling out*. The meanings of the smaller linguistic parts thus peeled out are ripe for discovery, thanks in part to the use of sentences with concrete meanings. On this last point Bloomfield preaches caution, recognizing the difficulty of translating parts of a sentence from one language to another.

This advice reveals what Bloomfield takes to be the most translatable expressions of a language, words for concrete objects and sentences with concrete meanings. In Bloomfield's approach, sentences are basic to the discovery process. Smaller constituent parts are discovered by comparison between sentences – through the process of peeling out. Bloomfield appears to think that sentences describing concrete situations can be readily translated from one language to another but the constituent parts of these sentences less so. Reliable correspondences between languages then are to be found between words for concrete objects and sentences describing concrete situations but not necessarily between the components, functional or otherwise, that make up those sentences.

Translation of a linguist's language into a target language is an expedient step in discovering the forms and meaning of that target language. However, there are practical and theoretical reasons to avoid translation whenever possible in the investigation of basic structure and meaning of a foreign language. Practical reasons include the added value to the learning experience which comes from deciphering first-hand language data without attendant explanation. Bloomfield mentions the 'interest and even excitement' that the discovery of the non-translated sentence parts can involve (Bloomfield, 1942: 13). It stands to reason that interest and excitement would be further enhanced if no translations were involved to begin with, provided that discovery is not thereby put out of reach. The question of when discovery is in reach, and when it isn't, brings up issues of theoretical interest, involving as it does inherent properties of language.

The form of the linguistic sign is arbitrary, which is to say meaning cannot generally be guessed from form. Furthermore, parts of an utterance are not easily distinguished. This second aspect of difficulty constitutes the parsing problem. Together, the arbitrariness problem and the parsing problem suggest that words and sentences should first be introduced in full view of what they denote. This is done through ostension, showing the reference of expressions while uttering them. Comparing such utterances to overcome the parsing problem is an aspect of ostension as well. As pointed out by Quine (1960), however, ostension is subject to various

kinds of indeterminacy. In Quine's example, a speaker utters 'gavagai' just as a rabbit scurries past. In spite of the saliency of the rabbit, a language novice witnessing the overall event cannot be sure of the meaning of 'gavagai', whether it means 'rabbit' or something else relevant to rabbits, their behavior or their classification.[1]

I argue that information flow plays a role in Quine's problem. I assume that the salience of the rabbit-scurrying event means there is a non-linguistic channel of information jointly accessible to the native speaker and the language novice. The native utters 'gavagai' to supply an expression to carry some of the same information carried on the non-linguistic channel, assuming that the utterance has any relevance to the perceived situation at all.[2] Even given such relevancy, the problem of indeterminacy comes about because the non-linguistic channel carries more information than a single utterance would convey.[3] But if information flow is involved in the problem, it should also be part of the solution. One approach to such a solution would be to isolate a unit of information of a size that can be conveyed by a single utterance and to associate such an utterance with the isolated unit.[4] That association, I further argue, would involve a sentence-sized utterance. I assume that sentences are the expressions that carry information in language and that this is determined by the grammar.

I have been developing an instrument for the purpose of discovering forms and meanings in any unknown language without reliance on translation (Werner and Olesova, 2015; Werner, 2017). I call the instrument an *ostension scheme*, although to fully capture all aspects of its use, I might have called it instead an *elicitation-ostension scheme*. My current goal is to refine this instrument to further facilitate the first-hand collection and storage of language data. The data is to be collected efficiently and stored in a highly transparent form, rendering it especially usable for investigators of the given language. I am attempting to achieve this goal in part through the kind of solution to the problem as suggested above.[5] Ostension schemes are designed to isolate units of information along non-linguistic channels of information and associate utterances from a target language to these isolates. This paper seeks to analyze how such schemes function. At the same time, I want to show how this practical problem raises issues of theoretical interest.

Ostension schemes are not intended to replace linguistic fieldwork, an area of linguistic research which has continued to develop since the time of Bloomfield's handbook and which has its own set of experts and sophisticated techniques. My analysis of ostension schemes is not intended as a comment on current linguistic fieldwork. My aim is to refine ostension schemes to make them a more practical instrument for elicitation and ostension, utilizing properties of natural language that might otherwise be overlooked. In their current stage of development, ostension schemes are useful only for eliciting certain kinds of language data. Sentences elicited in this way are basic observation sentences. These sentences correspond to scenes that can be visually represented, involving restricted vocabulary and restricted syntactic or morphological forms.

A theoretical understanding of ostension schemes should motivate and generalize practical solutions. Existing theories of language or language use are not entirely adequate for this purpose. In particular, the relationship between linguistic meaning and information flow typically gets little treatment.[6] I propose that information flow plays a crucial role in the monolingual elicitation of language forms. Ostension schemes seek to harness this flow in precise ways. The investigation of ostension schemes should help bring the relation between aspects of information and linguistic meaning into clearer relief, which in turn can shed light on other areas of language use.

Simple observation sentences of the sort I investigate here can be seen as links along an information channel. To bring this out, I borrow certain notational devices developed in Optimality Theory (OT), especially bidirectional OT, which associates sentence form with an input on the production side, and sentence form with an output on the interpretation side. The input-output organization in bidirectional OT makes it appropriate for clarifying how sentences can serve as links along an information channel. At the same time, my approach to the relation between meaning and information sets it apart from mainstream bidirectional OT. There it is assumed that the input to production and the output to interpretation is sentence meaning. By my approach, inputs and outputs are information itself, while meaning is what connects information to linguistic form. I see information as a two-part transmission along a channel, with sentences involved in bringing these two parts back together, recreating relations that exist at the source of the information, exactly the reason that sentences are units of information.

2. Ostension Schemes

An ostension scheme is an instrument for monolingual elicitation of natural language data as well as presentation of that language to a language learner or investigator. Monolingual elicitation in its purest form is a way of discovering a language which is not the language of the investigator, using only external props and the target language itself (Pike, 1977; Makkai, 1986; Everett, 2013). There are certain inherent obstacles to this elicitation. These include the arbitrariness of the linguistic form (Whitney, 1971; Saussure, 1983), the parsing problem (Joos, 1950), and the indeterminacy problem (Quine, 1960). Ostension schemes are designed to address some of these obstacles and to overcome them to the extent feasible. These obstacles revolve around the problem of form and meaning, and they are at least partially overcome by coupling linguistic utterances to the flow of information. Information is something that exists independently of linguistic form while linguistic meaning is not. Because of its semi-autonomous nature, information can be stored, manipulated, and transmitted by non-linguistic means. If non-linguistic information channels accompany linguistic channels, discovery of forms and meanings becomes possible.

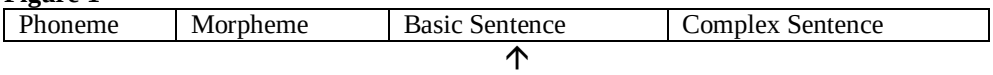
Ostension schemes first target basic sentences, linguistic forms that convey information represented by the scheme. Subsequent comparison of minimal sentence

pairs allows for discovery of sentences parts, especially morphemes and their meanings. Minimal morpheme pairs can aid in the discovery of phonemes. I conceive of the first aspect of the analysis – recognizing sentences and their meaning – as gaining access to the hierarchy of linguistic primitives. I conceive of the second aspect – discovering sentence parts – as movement within the hierarchy.

Ostension is a way to express the meaning of language by gesturing or otherwise appealing to extra-linguistic reality, especially through visible presentation. *Ostensive definition* is introduced by Johnson (1921) as a form of definition requiring the appearance of an object or property in perception. Robinson (1954) talks about 'the *ostensive* method of word-thing definition', defining it as 'any method which does not rely on words alone.[7] Wittgenstein, in discussions of ostensive definition, is finally dubious of ostension as a way to discover the forms of individual words, given that understanding individual words presupposes knowledge of the grammar of the language containing them (Wittgenstein, 1968 and 1969; Fogelin, 1976; Engelland, 2014). Going beyond such limitations, one can conceive of ostension not to single words denoting objects but to entire sentences which denote scenes. Quine (1960) considers ostension of an entire sentence (or a complete utterance), as when a native speaker utters 'gavagai' as a rabbit scurries by. Quine is concerned with a fundamental indeterminacy in ostension, since the particular aspect of the scene intended is not made clear by the salience of the rabbit, or even a gesture to it. Quine suggests the linguist can solve this problem by 'taking the initiative and querying combinations of native sentences and stimulus situations so as to narrow down…guesses to (the linguist's) eventual satisfaction' (26). Ostension schemes provide such combinations, isolating aspects shared between multiple scenes and in this way making the meaning of an utterance clear. Ostension schemes distinguish sentences from entailments of those sentences and from their precizations (Naess, 1966). The work is done through matrices. Rows of a particular matrix are introduced through pictures. Checkmarks appear in these rows, at the intersection with certain columns. For each column, a target language speaker, the language consultant, is asked to produce an utterance which applies only to the checked rows of the column and which does not apply to the rows that are unchecked. Each elicited sentence is entered at the head of its column, as a recorded sound file or under a phonetic or orthographic rendering. Relations of entailment and precization in a sense restricted to the particular ostension scheme follow from this elicitation procedure and can be read visibly from the matrices. Sentence A entails a sentence B on the ostension scheme just in case every row checked for A is also checked for B. Sentence A is a precization for sentence B on an ostension scheme just in case every row checked for A is checked for B of the scheme but there are rows checked for B that are not checked for A. The relations visibly represented on the ostension schemes help in clearing up the simplest level of indeterminacies that worried Quine, with the caveat that an ostension scheme may be too incomplete to remove such indeterminacies in a particular case.

As mentioned, elicitation is conceived as accessing a linguistic hierarchy of a language. The linguistic hierarchy for a language is an abstract arrangement of the elements of that language, from simple to complex, with complex items built up in some way from simpler components. I assume that morphemes are concatenations of phonemes and basic sentences of morphemes, and that complex sentences are derived from basic ones, perhaps transformationally. A template of a linguistic hierarchy is shown in Figure 1, but each natural language entails a distinct such hierarchy.

Figure 1



The access point provided by an ostension scheme is at the level of the basic sentence. I make the further claim that ostension schemes give access to the linguistic hierarchy at just this point because basic sentences are units of information in language. Information is an autonomous entity, and therefore, a linguistic unit of information – a sentence – can stand on its own. The meaning of such a unit is revealed by the information it carries.

The basic meaningful parts of a sentence – morphemes – or the basic contrastive values – phonemes, however, are not independently discernable. This is the parsing problem. Smaller units making up a sentence-sized utterance are discovered only through comparison. Ostension schemes help isolate minimal sentence pairs for comparison, making way for such discovery. Minimal sentence pairs are sentences that differ by a single linguistic element – morpheme or phrase – and which are elicited from sets of scenes themselves minimally different. The comparison of minimal sentence pairs leads to the discovery of smaller or contained linguistic elements as well as their meanings. Word-order facts are revealed too. I conceive all such discoveries as movement along the linguistic hierarchy from the point of access. The discovery of word and morpheme ordering is part of this movement. This procedure corresponds to Bloomfield's peeling out operation, previously mentioned.

An essential feature of ostension schemes for eliciting language is that they involve no primary reliance on translation. This has practical value, especially because it means elicitation can often go ahead without requiring bilingual experts. At the same time, the non-reliance on translation raises new problems. One such problem is that in their current development, ostension schemes are limited in the types of sentences and words they can be used to discover. They may help in discovering language to describe spatial relations or events and states that can be visually represented. They may help in discovering syntactic patterns of simple declarative sentences, but hardly, for example, the patterns of modal or conditional sentences. While it may be possible to extend the scope of ostension schemes, I assume that a deeper understanding of how ostension schemes work in their current

guise is first necessary. A preliminary step, given my overall set of assumptions, would be to understand how natural language is involved in the flow of information.

I provide a sample ostension scheme in Figure 2.

Figure 2

	A	B	C	D
	✓	✓	✓	
	✓	✓		✓
		✓		
	✓			

The following sentences in English are compatible with this scheme.
A: There's a table.
B: There's a book.
C: The book is on the table.
D: The book is under the table.

Sentence C and D are a minimal pair. Both sentences separately entail sentence A and sentence B on the ostension scheme – the row checkmarked for C is check-marked for both A and B, with the same true of D. C and D are each a precization of A and B on the ostension scheme since there are rows checkmarked for A or B which are not checkmarked for C, with the same true of D. C and D, a minimal sentence pair, can be compared, allowing the segments by which they differ, /on/ and /under/, to be peeled out. A plausible hypothesis for a user of this scheme would be that /on/ and /under/ are morphemes in the language and that they mean on and under, respectively.

Any ostension scheme can be further expanded to strengthen or weaken such conclusions. In this scheme, there are sentences beyond those listed that the

consultant might have provided, and other interpretations than those mentioned that the linguist might have guessed at. Sentence C might have meant that the table is under the book and sentence D might have meant the table is over the book. Still, the scheme does narrow down possibilities. It guides the target language consultant to produce a suitable utterance, and it limits the hypotheses a student of the language should entertain about possible meaning. Adding more rows and columns to a scheme narrows down possibilities further. A column in an ostension scheme would uniquely specify an item of information only in the limit.[8] Practically speaking, however, only a small number of rows and columns are typically needed to elicit desired forms.

Access of the linguistic hierarchy at the level of the basic sentence and movement within the hierarchy to morphemes and phonemes goes against a more familiar order of linguistic analysis and teaching. That typically starts from smallest units of sound and builds these into morphemes and sentences (Harris, 1946; 1951). However, the order proposed by the method proposed here is in accord with earlier thinking on the subject. Bloomfield (1914) provides relevant discussion. After noting a generally followed order – starting with 'distinctive sounds' then turning to 'morphology and syntax', and going from 'big classes of words' to 'inflection of each', to 'such matters as derivation and composition' before finally discussing 'uses and interrelations of the various inflected words in the sentence (syntax)' – Bloomfield makes the following point.

> This procedure is a makeshift, for it has long been recognized that the first and original datum of language is the sentence, – that the individual word is the product of a theoretical reflection which ought not to be taken for granted…that the grouping of derived and inflected words into paradigms, and the abstraction of roots, stems, affixes, or other formative processes, is again the result of an even more refined analysis (in Hockett, ed., 1970: 61).

Ostension schemes allow for monolingual elicitation through circumvention of the arbitrariness of the linguistic sign. My basic premise is that this circumvention is made possible by information flow. I propose that information has a semi-autonomous existence, unlike linguistic meaning, which is inseparably tied to the linguistic expression itself. The role of information flow and the connection to linguistic meaning become clear in the functions of the rows and columns of the ostension scheme. The rows of ostension schemes, each introduced by a pictorial representation of a scene, can be conceived as independent channels of information flow. Columns, to be headed by the utterances elicited from target language speakers, contain checkmarks in certain rows. The checkmarks indicate information shared between rows. Rows lacking checkmarks do not share this information.

Rows that share checkmarks share information, but this raises the question of what it means to share information. Information flowing along a channel from a source is spatially and temporally distinct from information flowing along a separate channel from a different source. I will call two such distinct flows tokens of in-

formation flow. Distinct channels cannot share information in its guise as token. Any information must be shared as type. The column with its pattern of checkmarks itself represents information as type. The sentence elicited to head the column is not associated with any single channel or source. The sentence represents what the column itself represents – information as type. The sentence represents this information in virtue of its form, to which is associated a meaning. But since the sentence is not part of any channel, it does not appear under use. I claim that these sentences appear under mention, but mention in a special sense that I will make clear later. Should the same sentence be used in a communicative context – appearing under use – it would carry a token of information of the same type. These conclusions hint at the relation between sentence meaning and information, understood as type or token. It is already clear that the capacity to carry information is associated with the meaning of the sentence but that meaningfulness alone does not entail that the sentence carries information.

It is a goal of this paper to sharpen the concepts introduced in the previous paragraph and spell out more clearly how these concepts are interrelated. To anticipate some of that discussion here, I want to consider how the rows in an ostension scheme – introduced as they are by pictures or photographs – can be considered channels of information flow. How, for example, does a photograph carry information? Photographs are non-arbitrary displays. They do not have conventional meaning, in contrast to linguistic expressions, but they do carry information.[9] The components of the display are mechanically triggered in the creation of the picture, as when pixels receive a color value based on the wave-lengths of light waves impinging on a receiving surface. Leaving aside for a moment photo-shopping or computer generation, a photograph is veridical, portraying an actual scene. The photograph carries information that distinguishes the scene from other scenes. A photograph of a red ball in a chair distinguishes it from scenes in which a red ball is not in a chair. By carrying information that a red ball is in a chair, the picture distinguishes the source scene from scenes in which this is not the case. The same photograph would also carry the information that there is a ball in a chair, that there is a red ball, that there is a ball, and that there is a chair.

The photograph carries information by converting physical disturbances of one sort into physical disturbances of another sort. Finally, at a receiving end of the communication channel, the incoming physical disturbance is cashed out as some set of discrete items of information. Cashing out means interpreting the signal. I will call each item thus cashed out an *informational isolate*. An informational isolate groups the source of the information with similar sources and isolates the source from sources which differ by some criterion. Isolates cashed out from an incoming disturbance can be arranged as a partial order, forming a partially ordered set or poset.[10]

I assume that the nature of these isolates is constrained by what a human being can perceive, think about, or express – linguistically or otherwise. However, I do not speculate on the internal structure of these isolates and only consider them in

terms of what they do – grouping a source with other sources of a similar kind and distinguishing it from sources that do not fall under the same criterion. I represent an isolate as a sentence written in small caps, such as THERE IS A RED BALL. The form of this representation carries no significance. The poset of isolates is a structure <A, ≤ >. A is the set of isolates. For isolates *a* and *b*, members of A, $a \leq b$ iff the set of sources isolated by *a* is a subset of the set of sources isolated by *b*. a < b, iff $a \leq b$ but not $b \leq a$. A tree can be constructed from a poset <A, ≤ >. Let tree$^{<A,\leq>}$-*a* be a structure <A', ≤, *a*> constructed from poset <A, ≤ >, with A' ⊆ A, and *a* a minimal element in A' so that for every *b* in A', $a < b$ (Landman, 1991). When it is obvious from which poset the tree is constructed from, I will label it as tree-*a*, where *a* is an element in A and the minimal element in A'.

Isolates and the posets they belong to figure into information loss. At points distance from a source, less information can typically be recovered. Up close, a red ball is visible. Further away, only a patch of red can be seen. Information is lost in a discrete form – as an isolate and all isolates that depends on it in a poset.

The significance of checkmarks in a column of an ostension scheme can be related to informational isolates and ordering between columns. Information in a column shared between rows is shared as an isolate. That means columns represent isolates. Any particular row has checkmarks in multiple columns. A set of columns A can be partially ordered by the subset relation. For columns *a* and *b* in A, $a \leq b$ iff the rows checkmarked for *a* are a subset of the rows checkmarked for *b*. Relations between isolates, or the columns representing them, determine entailments or precizations on the scheme of the sentences that head them. For Sentence$_a$ and Sentence$_b$, heading columns *a* and *b* in A respectively, Sentence$_b$ is an entailment of Sentence$_a$ iff $a \leq b$. Sentence$_a$ is a precization of Sentence$_b$ iff $a < b$. The notions of entailment and precization as defined here are relative to a particular ostension scheme. Column A in Figure 2 shows the isolate THERE IS A TABLE. Column C in Figure 2 shows the isolate THERE IS A BOOK ON A TABLE. A sentence heading column A would be an entailment of a sentence heading column C in the limited sense proposed here. A sentence heading column C would be a precization of a sentence heading column A in the same limited sense. 'There is a book on a table' is such a precization of 'There is a table'. 'There is a table' is such an entailment of 'There is a book on a table'. But as before, a particular ostension scheme may have too few rows to represent the actual relations of entailment or precization of the language. The situation can be improved, in many case although not invariably, by adding more rows or columns. Reference to entailments and precizations throughout this paper will only be in the restricted sense as I have defined it here.

A sentence elicited for a column in an ostension scheme is associated with an informational isolate and this relates to its meaning. The sentence itself appears under mention, since it is not part of a communicative act. Were it to be uttered in an appropriate communicative context, it would appear under use. In the latter case, it carries a token of information of a type. In the former, it carries no information at all, merely having the potential to carry information of a type. The meaning of a

sentence, however, does not change under use or under mention. I take this fact to be a clue of the relation between information and linguistic meaning. It shows that although linguistic meaning is associated with information, it is not the same thing as information. I return to the nature of this association later in the paper.

Several outstanding questions regarding ostension schemes can now be asked. What is information and what is information as type versus information as token? What is it for a sentence to appear under mention as opposed to under use? How is a sentence under mention equivalent to a column in an ostension scheme? What is the role of meaning in sentences under use? How is meaning involved in information flow?

To facilitate the following discussion, I adopt input-output tableaux as is standard in Optimality Theory. I therefore give a brief introduction to some aspects of Optimality Theory next.

3. Optimality Theory

Optimality Theory (OT) is an approach to linguistic analysis that relies on an input/output mechanism to predict and explain linguistic forms. In its most basic form as used in phonology, an input is a string of phonemes. The output is the most optimal form from a list of candidates, the result of a competition regulated by a set of ranked constraints. The input is an abstract representation of a form, whereas the output is tied to the physical form of an expression, a phonetic string.

OT competitions are represented on tableaux. The input is found in the upper left-hand corner, with constraints appearing along the top of the tableau in the order of their ranking from left to right. Candidates appear on the left-hand side, below the input. Constraints assign violation marks to any candidates that do not adhere to defined requirements. Constraints weigh against forms that are structurally marked as well as against forms that do not preserve basic contrasts in the language. Violation marks are tallied to choose the winning form. To illustrate such a competition and its outcome, I present a simplified tableau from Kager (2000), with the relevant morphemes rendered both in the International Phonetic Alphabet (IPA) and in standard orthography.

(1)

	/bɛd/	DON'T VOICE CODA	MAINTAIN ORIGINAL VOICING
a.	[bɛt] ('bet') ←		*
b.	[bɛd] ('bed')	*!	

The input here is the string of phonemes /bɛd/, with diagonals indicating the phonemic status of these elements. Two relevant candidates from a larger set of plausible candidates are shown, [bɛt] and [bɛd], with square brackets showing their phonetic status. The constraint DON'T VOICE CODA, a markedness constraint, penalizes candidates with final voicing. The second candidate incurs a violation of this constraint. The constraint MAINTAIN ORIGINAL VOICING, a faithfulness con-

straint, penalizes candidates that change features vertically, from input to output. The first candidate incurs a violation of this constraint. Given the ranking of DON'T VOICE CODA over MAINTAIN ORIGINAL VOICING, the violation by the second candidate is fatal. This is indicated by an exclamation mark after the decisive asterisk. The arrow points to the winner of the competition, the finally-devoiced form [bɛt]. The example is drawn from Dutch, a language with word-final devoicing where the minimal pair [bɛd] versus [bɛt] is not found. If the ranking of the constraints were reversed, the tableau would represent English, where [bɛd] and [bɛt] do constitute a minimal contrasting pair.

Optimality Theory is originally a framework for phonology, as in this example, in which strings phonemes in the input are spelled out as strings of allophones. The framework has been applied to syntax and semantics as well. Syntactic tableaux, and the analyses they stand for, are to be paired with semantic ones. A syntactic tableau is a production tableau. Its output is a linguistic form. This form in turn becomes the input for a semantic tableau, an interpretation tableau. The input of the production tableau and the output of the interpretation tableau are identical, sentence meaning. By one line of development, bidirectional OT, the perspective of the hearer enters into the competition for the production form. This development captures the idea that a speaker will choose a form that best allows a hearer to recover the original input (Grimshaw, 1997; Lestrade et al., 2016; Hendriks and de Hoop, 2001; Hendriks, 2016; Hogeweg, 2016).

This development of OT will have relevance further on in this paper. The joining of a production tableau with a set of interpretation tableux is particularly useful for modeling information flow in language, given one critical caveat. First, however, to illustrate the joint behavior of a production tableau with one or or interpretation tableaux, I reproduce the following example from Lestrade et al. (2016).

In this example, a production tableau is associated with two interpretation tableaux:

PROD	bit(pig, woman)	ECON	FAITHL	PROM
a.	→ *woman pig bit*			
b.	↔ *woman-OBJ pig bit*	*!		

INT_a.	*woman pig bit*	ECON	FAITHL	PROM
i.	→ bit(woman, pig)			
ii.	bit(pig, woman)			*!

INT_b.	*woman-OBJ pig bit*	ECON	FAITHL	PROM
i.	bit(woman, pig)		*!	
ii.	→ bit(pig, woman)			*

This combination of tableaux is an example of strict bidirectionality. The form chosen for the original utterance is not the one that wins the competition in production tableau. Before a winner can be selected, each member of a set of

production candidates will be placed as input in a separate interpretation tableau to determine whether, given such a production output, a hearer would be able to recover the speaker's intended meaning. Here that work is done by the constraint FaithL, a constraint requiring everything said by the speaker to be interpreted. When (a) is the input for an interpretation tableau, the original predication is not recovered by the ranking. (PROM, for Prominence, is violated whenever pig, lower on the animacy hierarchy, acts on woman). Therefore, the winning form is (b). This analysis captures the idea that the speaker anticipates what the hearer will be able to recover in choosing a production form.

This arrangement lends itself to the modeling of information flow since the input of the production tableau is also the targeted output of interpretation tableaux. That input was identified in the example as a sentence meaning. The speaker has that meaning in mind and selects a linguistic form which allows a hearer to recover that meaning. However, in my view there is a circularity in referring to sentence meaning in the production of a sentence and it is not plausible to me that the logical form of the input determines the syntactic form of the resulting linguistic expression. I propose below a different form for the input to take, to clarify the connection between non-linguistic information with linguistic form. But first, I have to consider how information from a source is passed along in the non-linguistic case.

4. Information

I next discuss two simple ideas concerning information. On the one hand, information in the sense relevant to this paper is information about something. A photograph carries information about a scene. A photograph is in fact a mechanical relay for information derived from a source, sending that information along a channel to an eventual receiver. Sentences – simple observational sentences – similarly can carry information about a scene or situation. In this, they mimic the behavior of non-linguistic relays such as photographs. But typically, a sentence will carry much less information than a photograph.

On the other hand, both mechanical relays and sentences can be misleading, false, or fictitious. A photograph can distort reality, or even be deliberately doctored to mislead. A computer-generated image, virtually indistinguishable from a photograph, carries information from no real source. It could be said to be carry no information at all. But it also could be said to carry virtual information or even to create the information it carries.

A sentence can appear under use or under mention. Under use, a sentence can be false or misleading, not faithful to the source it represents. But a fictitious sentence is also a sentence under use. In form it may be indistinguishable from a non-fictitious reporting sentence, even if there is no question of its being faithful to any source. The information it carries is fictitious or virtual. Such a sentence can be said to create the information it carries. A critical comparison to make is this. The

mechanisms by which a photograph carries information, accurately or not, and the mechanisms by which it creates information, are the same mechanism. Similarly, the mechanisms by which a sentence carries actual information or creates information should be the same too.

Information flows along a channel, a physical medium connecting a source to a receiver, or a serial arrangement of inter-connected media (Shannon and Weaver, 1949; Dretske, 1981; Barwise, 1989). Information originates from a source, with events and states at that source triggering physical disturbances, an output. The information arrives to a receiver as a physical disturbance as well, an input. If the channel involves a serial arrangement of media, there will be relays at the interfaces – input/out devices that convert a disturbance of one form into a disturbance of another.

What is it that flows along such channels? Dretske (1981), in his summary of the quantitative theory of information of Shannon and Weaver (1949), avoids giving a definition of information. Dretske does distinguish three types of information: information at a source – I(s), information at the receiving end – I(r), and information at the receiving end that comes from the source – $I_s(r)$. It is the last of these that is relevant in this paper. In previous work, I proposed that information is a physical disturbance with a recoverability property. The recoverability property is what allows a receiver to learn about a source from the physical disturbance. Here I elaborate this recoverability property further.

Crucial points along an information channel – source, relay, and receiver – can be represented by input/output tableaux, and it is here that my treatment on non-linguistic information begins to take on aspects of an OT treatment of language. To begin, consider the following.

(2)
Source:

Input:	σ	Excitation 1	Excitation 2	Excitation 3	…
Output 1:	Disturbance n_1	✓			
Output 2:	Disturbance n_2		✓		
Output 3:	Disturbance n_3			✓	
…	…				

Relay:

Input:	Disturbance n	Transformations
Output:	Disturbance n + 1	✓

Receiver:

Input:	Disturbance n + 1	Reversals	Cognitive enhancements
Output:	Poset of isolates	✓	✓

Events and states at the source create physical disturbances that emanate forward, each along an appropriate channel. The events and states are input, and the disturbances they create are output. At a relay point, disturbances of one sort are

mechanically converted into disturbances of another. At the receiver end, the incoming disturbance is cashed out as a poset of informational isolates. This cashing out involves not only reversals of the original excitations and their subsequent transformations but certain cognitive enhancements as well. By these enhancements, a two-dimensional photograph can be interpreted as a three-dimensional object or a black and white picture can be taken to represent a vase of colorful flowers. But there are limits to how much enhancement is possible. Actual colors from a black and white photo cannot be recovered. An object unseen behind a vase will remain unseen.

An isolate is recovered from properties of the disturbance. The disturbance comes from the immediately proximate relay, or, in cases of direct perception, from the source itself. The poset of isolates represents aspects of the source. The disturbance from which it is recovered is always vulnerable to further loss and distortion as it travels along the channel. These distortions affect the recovered poset and how faithfully it represents the source.

Reviewing the three previous tableaux again, however, it is clear that something is missing. The poset of isolates, appearing as output to the third tableaux, applies to the source, the input to the first tableau. But how is the connection between the poset and source to be made?

Any physical disturbance emanating from the source entails a causal fact. That causal fact is that the disturbance originated from a source. The incoming disturbance is information about the source only if the receiver is attuned to the causal fact and can associate properties of the disturbance with properties of the source. Without this attunement, the information is not about anything. It is not Dretske's information of type $I_s(r)$. To capture the idea of information about a source, I allow that the causal fact underwrites an abstract marker sigma. This sigma accompanies the disturbance from the source, across all relays, and arrives to the receiver to the final destination where it is passed onto the output. The tableaux can then be rewritten as follows.

(3)
Source:

Input:	σ	Excitation 1	Excitation 2	Excitation 3	…
Output 1:	Disturbance n_1 σ	✓			
Output 2:	Disturbance n_2 σ		✓		
Output 3:	Disturbance n_3 σ			✓	
…	…				

Relay:

Input:	σ Disturbance n	Transformations
Output:	σ Disturbance n + 1	✓

Receiver:

Input:	σ Disturbance n + 1	Reversals	Cognitive enhancements
Output:	σ Poset of Isolates	✓	✓

The existence of sigma is a formal hypothesis intended to explain various observed facts. Sigma itself is abstract and not physically represented by properties of the disturbance. While the disturbance itself undergoes changes in form as it travels through a medium or passes from one medium to another, sigma is an invariant accompaniment of the disturbance throughout its life cycle. Sigma is a necessary ingredient to the flow of information and, without it, there can be no recovery of properties from the source.

As mentioned, sentences and other forms of representations can be false, misleading, or entirely fictitious. This has implications for the status of sigma. Consider the drawing of a landscape. While it may be a faithful rendering of an actual landscape – connected to an actual landscape existing in space and time – it may also be a fantasy of the artist. Even as a fantasy, given a sufficiently realistic technique, the picture may be indistinguishable from a real portrayal. The difference between the two kinds of drawings is not found in their physical properties. The difference is in the value of sigma. This value is only established independently, as a matter entirely separate from its form. The value can be established from the history of the drawing, from its likeness to an actual landscape, and so on. All this means that there is variability to the values sigma can take. Sigma is a variable. It can have one of several values, or even no value at all.

That sigma is a variable has consequences for what can be said about the isolates in the poset. Rather than saying that they represent properties of the source, it must be said that the isolates restrict possible values of the source variable, sigma. In perceiving a scene, an artist cashes out isolates from incoming sensory input. The artist draws or otherwise fashions physical shapes to replicate the function of the isolates. The same point carries over to words and structures in a sentence. Rather than saying that these directly represent properties of the source, it should be said that words or sentences restrict a source variable. But here is where truth or falsity comes in. When sigma is assigned an actual situation as its value, the constraints imposed on sigma push back on the representation. If the actual source adheres to the constraints, the representation is faithful, or true. If not, the representation is not accurate, or false. In any contest between reality and representation, reality wins.[11]

5. Language

Information flowing along a channel has a dual aspect, and understanding this dual aspect is essential to understanding how a disturbance carries information about a source. This dual aspect also helps explain how information can be carried by linguistic means – sentences. Sentences too have a dual aspect. They have meaning but they are also, potentially, about something. To clarify this point, first I will

explain how sentences are units of information and second, how the meanings of sentence-parts enable that sentence to carry information from a source.

5.1 Sentences as units of information

Information incoming along a channel is cashed out by a receiver as a poset of isolates <A, ≤ > with an accompanying sigma variable. The poset and sigma are the raw materials for the input of an utterance. Those raw materials will be pared down by speaker choice, what a speaker chooses to say about a source in one breath. Sigma goes into the input, as does an isolate-tree selected by the speaker from the poset. The speaker selects an isolate *a* from A. *a* will serve as a lower bound for tree-*a*. Tree-*a* consists of *a* from A and every isolate *b* from A such that $a < b$. I assume the selection of a single isolate automatically brings with it all isolates ordered above it. These higher isolates place no further restrictions on sigma but instead are implied by the original selection.

This input can be represented on a linguistic production tableau as follows.

(4)
Linguistic production tableau

Input:	tree-*a* σ			
Output:	sentence σ			

This production tableau shows inputs converted to linguistic forms. The input pairing of sigma with poset-*a* is matched by an output pairing of sigma and sentence. The lexical items constituting the sentence, and their syntactic and morphological arrangement, are to take over the function of tree-*a*. Sigma itself is simply passed from input to output. Sigma is abstract, not carried by physical properties of the incoming disturbance. It is underwritten by the causal fact that a disturbance has a source. For a receiver to treat the incoming disturbance as information requires that the receiver be attuned to this causal fact. Sigma must be carried over to the sentence. I look to the grammar to make this happen.

This point goes to the status of the sentence as the unit of information in language. Harris (1988) saw the basic sentence in these terms and argued that information is created in language through predication and through limitations on such predication. To predicate is to say something of something else. This reduces possibilities. 'red' predicated of 'the bird' in 'the bird is red' forms a description that rules out the bird being blue or black. In Harris's view, since predication happens at the level of the basic sentence, sentences are what creates information. However, against this view one can argue that this notion of predication is not sufficient to explain how sentences carry information from a source. It doesn't explain the right kind of aboutness or how sentences carry Dretske's information of type $I_s(r)$.

Harris (1991) does take up one notion of aboutness.[12] He says of the sentence 'Trees fall' that it doesn't mean on the one hand there are trees and on the other hand, there is a falling. The falling is predicated of trees. The sentential predicate is about the subject. I would argue that this notion still does not go far enough. Predicating falling of trees does not generate information about a source. While falling is predicated of trees, the falling of trees also needs to be predicated of a source.

I posit that there are two layers of predication involved in a sentence, an explicit layer encoded in the structure of the sentence and an implicit layer which comes about from the status of the expression as a sentence. Falling predicated of trees reduces possible states of the trees, but that predication itself needs to reduce possible states at the source. The implicit layer of predication would in fact be the more basic one, since not all information-bearing sentences have a clear subject/predicate structure. The implicit layer derives from the dual aspect of information posited in this paper. Information traveling along an information channel consists of sigma and a physical disturbance, cashed out as a poset of informational isolates. The predication implicit in a sentence is the reunification of these two aspects. The sentence reconnects these aspects and it is for this reason the sentence is the unit of information.[13]

It follows therefore that there are two tasks for the grammar of a language. The first task is to connect a sentence to sigma. I propose the following constraints to handle this first task.

Dep/σ/: A candidate σ must be identical to σ in the input.
*[Non-complete sentence | σ]: An expression must meet the minimal structural requirements of a sentence to be paired with a sigma.
*[Sentence | no-σ]:a sentence not paired with a sigma is a violation.

Inputs in a production tableau are constituted by a sigma variable and a tree-*a* of isolates fashioned from poset <A, ≤ >. Outputs are the sigma variable paired with a sentence. These constraints see to the pairing. The first constraint is a Dep constraint. Dep constraints, mnemonic for *dependency* constraints, play an important role in the account I discuss below. For now, I simply note that Dep constraints require an element in an output to be supported by the input. The Dep constraint here requires any sigma associated with a sentence to be identical to sigma in the input. This sigma is a variable, since the actual value of this variable, if it has one, is determined independently from the incoming disturbance, as discussed earlier. (Since sigma is a variable, every instance of the variable along a channel must be given the same value.)

The remaining two constraints are markedness constraints. Markedness constraints assess outputs for how well they meet formal requirements. These markedness constraints restrict sigma to sentences. The definition of what a sentence is varies for particular theoretical approaches. In modern generative syntax, sentences are phrases built around explicit or implicit morphological units, heads. Other

approaches define sentences in various ways. Whatever the definition, these constraints rule out incomplete sentences, and they rule out sentences not associated with a sigma.

Together these three constraints capture the idea that sentences are the basic unit of information in language. The association between a qualifying form and a sigma variable is what makes the sentence the basic unit of language. Other units in language – phoneme, morpheme, phrase – are sub-atomic units. These do not stand on their own, a result guaranteed by the markedness constraints. Lesser expressions simply cannot carry information, a task requiring sigma.[14,15]

The following tableau shows the operation of the constraints.

(5)

	Isolate σ	Dep/σ/	*non-complete	*/no-σ/
a.	Sentence ← σ			
b.	non-sentence σ		*!	
c.	Sentence			*!
d.	Sentence σ’	*!		

The winning candidate in this tableau, indicated by the arrow, is a complete sentence accompanied by the sigma variable. Other candidates are incomplete or lack a sigma or contain a different sigma variable. Candidate (b) lacks sufficient structure to be a sentence. Candidate (c) has no sigma variable. This would be a sentence that was not about anything. Candidate (d) is associated with a sigma not found in the input. This sentence would be about a source from a different information channel. It can be observed that constraint ranking is not a factor in determining the winner of this tableau which can simply be attributed to the high ranking of these constraints.

An input for a production tableau is a pairing of a source variable and a tree-*a* of informational isolates. A winning output of such a tableau is a pairing of a source variable and a sentence. This explains how sentences are units of information and it points to the next step, explaining how a sentence restricts possible values of an accompanying sigma. In the input, restrictions are placed on the sigma variable by the tree-*a* of informational isolates. This role is to be taken over by the sentence, and it will be carried by its meaningful parts and their arrangement.

Earlier I mentioned aspects of bidirectional OT that I do not adopt. These involved the nature of the production tableau input and the interpretation tableau output. The proposal that these inputs and outputs should be sentence meaning in the form of a logical expression raises problems. Sentence meaning should not exist independently of sentence form, and rendering a production tableau input as a linguistic object leaves out a critical step in the explanation.

My production tableau inputs are information, the pairing of a sigma and an isolate-tree. These are language independent entities that can be expressed in linguistic form. These inputs have been cashed out from an incoming physical disturbance. The same information will need to reappear as output in an interpretation tableau. Meaning of the linguistic forms is what will capture this information and pass it along through the interpretation of those forms. That is the issue I turn to next.

5.2 The role of meaning

Meaning has a critical role in ushering information along a linguistic channel, but it is distinct from information. I am assuming a sentence in natural language comes with an input. For the simple observational sentences under discussion, the input is derived from information coming along a channel, a physical disturbance perceived through the sense organs. The disturbance is cashed out as a partially ordered set of informational isolates. A sentence targets this information, given a choice made by the speaker. The sentence reaches its target in virtue of the lexical items that make it up and their syntactic and morphological arrangement. Each lexical item has a meaning, and the syntactic and morphological arrangements are meaningful as well. But meaning is not what flows along a channel (Reddy, 1979), and consequently cannot be the input of a sentence. Meaning is rather how a connection to a source is made possible.

Information moves forward but looks backwards. It moves forward because physical disturbances emanate outward, either in the form of energy or as the actual displacement of physical matter. It looks backwards thanks to the implicit sigma variable it carries with it. This is my formal claim. At mechanical relay points, connections to the source are maintained by non-random conversions of one form of disturbance into another. To the extent these conversions are truly non-random and trackable, they are reversible. For linguistic expressions, connections are achieved through meaning. I attempt to capture this essential property of meaning with a particular kind of linguistic constraint, one that has already played a role in the previous section. By this type of constraint, the second task of the grammar will be fulfilled, that of connecting the sentence to the source variable. This connection replicates the function of the tree of isolates chosen by the speaker.

The backwards-looking property of information requires that meaning itself is backwards-looking. Meaning refers back to the input, suggesting a particular kind of linguistic constraint, a faithfulness constraint. That faithfulness constraints are the appropriate mechanism is also suggested by the idiom of a sentence or set of sentences as being a *faithful description*. Note that this faithfulness holds of the sentence. It is the sentence that is faithful to its subject matter, not the subject matter that is faithful to its sentence. A picture can also be a faithful likeness, but the subject matter of a picture is not said to be faithful to the picture.

Faithfulness constraints are part of the explanatory apparatus in OT. In this theoretical framework, faithfulness constraints ensure that outputs are anchored to

inputs in different ways. Two primary types of faithfulness are Max constraints and Dep constraints. To illustrate these constraints, I offer another digression into phonology, the linguistic sub-field from which they originated.

Max constraints (mnemonic for 'maximize inputs') penalize candidates which omit features found in the input. In phonology, such constraints militate against deletion. An example from English morpho-phonology involves regular plural nouns which are formed with a final /s/, a sibilant. When the singular form of the noun itself ends in a sibilant, however, adding a final sibilant would create a clash between sibilants. This pattern is marked, and therefore avoided in English. /dish/ + plural /s/ does not result in */dishs/. The avoidance of adjacent sibilants is due to a constraint against marked forms. But the combination does not result in */dis/ or */dish/ either, both the result of a deletion. The non-occurrence of deletion is explained by a highly ranked Max constraint which ensures that all elements from the input are found in the output.

Dep constraints (mnemonic for 'depend on input') work in the opposite direction. These constraints penalize candidates containing elements which are not found in the input. In phonology, such constraints militate against epenthesis, against adding segments to the output. Such added segments would be another way to avoid marked structures. As it turns out, epenthesis is exactly the mechanism by which English avoids adjacent sibilants. The English plural form for /dish/ is /dishes/, containing an extra vowel. This is the output form, even though it violates a Dep constraint. In OT, that means the Dep constraint would be ranked below other relevant constraints.

A tableau shows this competition.

(6)

input:	/dɪʃ+z/ (dish + s)	No Adjacent Sibilants	Max	Dep
a.	[dɪʃz] (dishs)	*!		
b.	[dɪʃ] (dish)		*!	
c.	[dɪz] (dis)		*!	
d. →	[dɪʃəz] (dishes)			*

The winning candidate is (d). While the word 'dish' is a single syllable, its plural form 'dishes' contains an extra syllable. The added syllable reveals the epenthesis and because of this epenthesis, the winning form actually violates Dep. This form is still preferred over Candidate (a), completely faithful to the input but with adjacent sibilants. It is preferred to Candidates (b) and (c), because these involve deletion. In (b), the plural marker itself is deleted. In (c), the final sibilant in the stem is deleted. The grammar of English prefers instead to add an element because by this analysis Max prevails over Dep.

I propose that the constraints needed to encode information into a linguistic form are akin to Dep constraints rather than Max constraints. Informational isolates are part of the input of a sentence. These isolates, or the tree they make up, represent speaker choice. It is not the business of grammar to require faithfulness to

speaker choice, to ensure that whatever a speaker chooses to say, they do say. It is the business of grammar to regulate linguistic forms. Dep constraints apply to linguistic forms. At the boundary between information and linguistic form, Max constraints would not.

Dep constraints play a crucial role mediating between information and linguistic form. These constraints require lexical forms and structures to be grounded in the input. As faithfulness constraints, they place limitations on chosen linguistic expressions, limitations that go backwards against the flow of information. The idea of forward-looking constraints is antithetical to the concept of information, and a constraint to call every dog a dog would be bizarre. A constraint requiring that the word 'dog' be used only if there is something dog-like in the input is in keeping with the idea of information as a series of disturbances such that each new iteration replicates properties of what came before it, going all the way back to the original source.[16] Dep/dog/ limits possible values of sigma and in so doing replicates a function performed by the isolate-tree in the input. These constraints allow linguistic expressions to participate in information flow. They are invoked by lexical choices and by the arrangement of such choices as provided by the morphological and syntactic structure of the sentence. In virtue of such constraints linguistic forms come to represent extra-linguistic entities, states, or events.

A possible objection to this proposal would be that Dep constraints constitute a grammatical requirement that all sentences be true. Dep constraints do make demands on a linguistic expression and if those demands are not met, the sentence may not be true. But this only means Dep constraints help determine if a sentence is true or not. The grammar can hardly enforce a commitment to truth.

A Dep constraint of the kind needed is an aspect of the lexical entry of word. The set of words in a language divides into those that are semantically saturated and those that are not, to adopt Frege's distinction. A saturated word is a word that is semantically complete on its own. An unsaturated word needs other words or expressions to be semantically complete. It has argument positions to be filled. Dep-Constraints pertaining to saturated words simply require the referent of the word to be found in the input. /dog/ might be taken as a saturated word in English. If so, Dep/dog/ would require only that there be a dog-like entity in the input. Dep-constraints pertaining to unsaturated words will be more complex. Faithfulness to these words with depend on the faithfulness to the input of their completed form. The word /walk/ in English is unsaturated. The constraint Dep_x/walk/ will penalize any candidate containing /walk/ unless the entity named in x walks in sigma.

It will be noted that in the majority of cases, the constraints are not presented as ranked. Ranking of constraints in OT is invoked when there are conflicting requirements placed on a candidate but for the most part it is safe here to treat these constraints as highly ranked.

There can be a conflict between constraints for saturated and unsaturated lexical items. Take the sentence: 'John doesn't have a dog'. Suppose that Dep /dog/ requires a dog in the input. But Dep_x/not/$_y$ would require that the Verb Phrase

named in y does not hold of the entity named in x. That constraint will only be satisfied if John doesn't have a dog. Ranking the constraints would be one way out of the problem. If $Dep_x/not/_y$ is ranked above relevant constraints, including Dep/dog/, then it overrules the constraint requiring there be a dog in the input. The candidate 'John doesn't have a dog' will prevail over 'John has a dog' for input tree-JOHN DOESN'T HAVE A DOG.

The use of Dep constraints for semantic interpretations brings up a host of issues in the compositionality of meaning and here I attempt to address only the simplest of cases. What these cases do demonstrate is how Dep constraints put restrictions on sigma and in so doing mimic restrictions placed on sigma by the input tree of isolates.

Dep constraints are one-way constraints and this means they are prone to vacuous fulfillment. This possibility raises an issue with entailments. A (non-equivalent) entailment will do equally well with respect to Dep constraints as the sentence it entails, and that means an entailment will result in a tie with the sentence that entails it. To take a particular case, suppose the speaker chooses the isolate THERE IS A RED BALL as a target isolate. The tree formed by this choice will include the isolate THERE IS A BALL. The Dep constraint for the lexical item /red/ in position x requires that red be an attribute of items named in the position x. However, the constraint only applies to sentences containing the word /red/. Since the sentence 'there is a ball' does not contain the word /red/, it does not violate this constraint. This Dep constraint alone cannot distinguish between sentences with /red/ and sentences without /red/ when there is red in the input. The case is general. Dep constraints do not favor a sentence over its entailments. But if that is the case, there is no guarantee that a sentence will prevail over its entailments in a competition.

This issue is illustrated on the following tableau, from which I have omitted a constraint for the unsaturated element $/be/_{x,y}$, that would require the element named in x to be in a location named in y.

(7)

	σ THERE'S A RED BALL < THERE'S A BALL	Dep/ball/	Dep/red/
a.	σ There's a ball.	✓	✓
b.	σ There's a red ball.	✓	✓

In this tableau, Dep constraints do not choose between the more informative 'there's a red ball' and its less informative entailment, 'there's a ball.' But given that the speaker chose the tree-THERE'S A RED BALL, the second candidate should be the winner.

I propose therefore to team any production tableau with a set of interpretation tableaux, following the method in Lestrade et al. (2016), reviewed earlier, even as I adopt different assumptions about the ultimate inputs and outputs. As was shown in

the earlier example, the winner of the production tableau, the actual form to be uttered, is selected only if it does better as an input in returning the original input. In that paper the input to be returned is sentence meaning. The input I want returned is a sigma with a isolate tree. But I do adopt the assumption that the winner of a production tableau is partly decided by outcomes of intepretation tableaux. It stands to reason that a speaker will take the hearer's perspective into account when choosing which form to utter.

The following production tableau repeats the earlier problem.

(8)

	σ tree-THERE'S A RED BALL	Dep/ball/	Dep/red/	Dep/large/	Dep/small/
a.	σ ← /there's a ball/	✓	✓	✓	✓
b.	σ ← /there's a red ball/ ↔	✓	✓	✓	✓
c.	σ /there's a large red ball/	✓	✓	*!	✓

Here, the intended winner (b) does prevail over its precization in (c) – a good thing – since /large/ is part of that string and invokes Dep/large/. This incurs a violation because tree-THERE'S A RED BALL does not isolate sources with large red balls from sources with non-large red balls.

The intended winner does not prevail over its entailment in (a) – a bad thing – which vacuously satisfies Dep/red/. But now consider two distinct interpretation tableaux which respectively take the two tied candidates as inputs.

(9) Interpretation tableau 1

	σ /there's a ball/	Dep/ball/	Dep/red/	Dep/large/	Dep/small/
i.	σ tree-THERE'S A BALL	✓	✓	✓	✓
ii.	σ tree-THERE'S A RED BALL	✓	✓	✓	✓
iii.	σ tree-THERE'S A LARGE RED BALL	✓	✓	✓	✓
iv.	σ tree-THERE'S A SMALL RED BALL	✓	✓	✓	✓

(10) Interpretation tableau 2

	σ /there's a red ball/	Dep/ball/	Dep/red/	Dep/large/	Dep/small/
i.	σ tree-THERE'S A BALL	✓	*!	✓	✓
ii.	σ tree-THERE'S A RED BALL	✓	✓	✓	✓
iii.	σ tree-THERE'S A LARGE RED BALL	✓	✓	✓	✓
iv.	σ tree-THERE'S A SMALL RED BALL	✓	✓	✓	✓

In the production tableau. the input was a pairing of sigma and an isolate tree. In the interpretation tableaux, such pairings are now candidates.

The first interpretation tableau takes the sentence /there's a ball/, a linguistic string, as input. All candidate trees listed do equally well for this input. Dep /red/, Dep/large/, and Dep/small/ are all vacuously satisfied.

The second interpretation tableau takes the sentence /there's red a ball/ as input. With this input, the candidate <σ, tree-THERE'S A BALL> is eliminated. Dep/red/ is violated. This is a reason for /there's a red ball/ to be selected over /there's a ball/ in the original production tableau. /there's a red ball/ does better in selecting the chosen isolate tree from the original input. That determines the output the speaker should select. The speaker had to take the hearer's perspective into account to determine the winning form.

But now consider how the hearer is to interpret the uttered sentence, /there's a red ball/. This is the input to the second interpretation tableau. On this tableau, candidates (ii), (iii), and (iv) do equally well, but candidate (ii) is the one that represents the input of the original production tableau. Why should the hearer choose this as the winner?

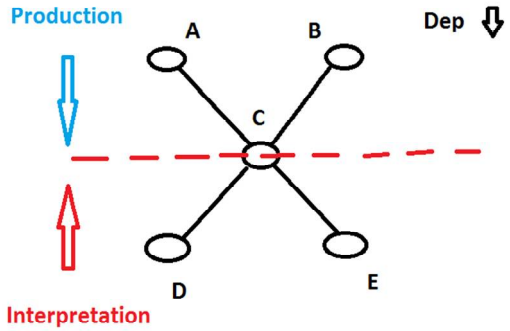
Among the three tied candidates in the second interpretation tableau, (ii) is the least restrictive. Because it is the least restrictive, it requires of the input the fewest vacuous satisfactions of constraints. The input /there's a red ball/ vacuously violates Dep/large/ for candidate (iii) and it vacuously violates Dep/small/ for candidate (iv). By selecting the least restrictive input, the hearer chooses the interpretation that most closely matches the uttered sentence.

In summary, the speaker should select the most restrictive sentence that satisfies Dep constraints with respect to the chosen isolate tree. The hearer should select the least restrictive isolate tree that satisfies the Dep constraints with respect to the uttered sentence. These asymmetrical requirements compensate for the one-way direction of Dep constraints. These constraints are one-way because they apply to linguistic items, rather than to the input, which in such tableaux is non-linguistic.

The same point can be made in another way. Suppose the figure below represents a poset cashed out from an incoming physical disturbance and suppose a speaker chooses tree-C as input for an utterance. This tree has as members A, B, and C. C < A and C < B.

For this input, Dep constraints will not distinguish between a sentence replicating A, a sentence replicating B, or a sentence replicating C. Still, the speaker should choose a sentence replicating C. Information flows downstream, from sources to receivers and from inputs to sentences. Dep constraints work upstream. The sentence to be uttered should be found as far downstream as possible in order to fully express what a speaker has chosen to say. The broken line in Figure 3 represents this limit. Sentences corresponding to isolates below the broken line will violate Dep constraints. The sentence at C will be incur no Dep violations for the lower bound C, but would for A or B.

Figure 3



The hearer is in the opposite situation. The hearer knows the sentence that has been uttered but not the isolate tree chosen by the speaker. Since information flows downstream and Dep constraints work upstream, the hearer should go as far upstream as the sentence allows. This would be to isolate C. For isolates above C, the uttered sentence will violate Dep constraints. Below C it won't, but only because of vacuous satisfactions. The lower bound for tree-C is a coordination point for speaker and hearer.

Meaning through Dep constraints has further consequences because sigma is a variable. Although there are various ways sigma can be filled, or left unfilled, the form of a sentence does not depend on the content of the variable. The content of the variable rather is constrained by the form of the sentence and this creates a flexible system which allows for sentences of different types. The interaction between Dep constraints and the variable also explains the function of ostension schemes. I turn to these topics next.

6. Kinds of Sentences

Extracting information from a channel involves the interplay of proximate and distant sources. The proximate source is the immediate purveyor of the physical disturbances to the receiver. Language is sensitive to this difference, above and beyond its role in information transfer. Indexical features are concerned with the proximate source, the speaker, and the speaking context. Evidentials indicate the nature of the disturbance reaching the speaker. I leave questions about indexicals and evidentials for future research. For now, I am interested in several cases involving information flow that can be understood through this interplay of proximate and less-proximate sources – the involvement of these sources in the transmission of information, and their involvement in interpretation.

6.1 Veridical sentences

The first set of cases are veridical sentences, by which I mean sentences presented as representations of what is real. As I define them, veridical sentences are not

necessarily true, but they are presented as true. The speaker is held to what they say, and this is a consequence of Dep constraints. I have already discussed veridical sentences at some length, these constituting the default case. These are cases where the speaker speaks about an actual situation and the hearer takes the speaker as doing so. Sigma is filled with an actual source value. The hearer fills in this variable based on who the speaker is and perceived connections between the speaker and the source. The strength of these connections helps determines the degree of faith a hearer will put into what the speaker says. Whenever sigma is given an actual value, reality pushes back against the constraints. The constraints on the variable become constraints instead on the linguistic items. If the constraints are not satisfied, the utterance is rendered false. A veridical sentence can be true only if the restrictions it applies to sigma hold of sigma's value.

A distinct set of cases are sentences under mention, including the special case of sentences under mention as they participate in ostension schemes. There is also the set of fictional sentences.

6.2 Sentences under mention and ostension schemes

A sentence under mention is neither true nor false. There are reasons to insist on a uniform treatment of all sentences, whether veridical, under mention, or even fictitious. This is made particularly clear by cases in which the status of a sentence is unclear. Some sentences cannot be recognized on first acquaintance to be of one kind rather than another. When a receiver eventually comes to learn that a sentence is veridical rather than fictitious, or under mention rather than in use, the manner of understanding the sentence does not change. Therefore, all such (declarative) sentences should be related to their input in the same way, including sentences under mention. Any input is comprised of a sigma variable constrained by an isolate tree. For sentences under mention, however, that tree is vacuous.

With sentences under mention, there is no push-back from sigma through the constraints. The sigma variable remains unassigned. The replication of isolate tree by Dep constraints is trivial. Nevertheless, the constraints are still in operation, and that is why a sentence under mention is not meaningless even if it doesn't have a truth value.

Sentences elicited for an ostension scheme, sentences to head the columns in these schemes, are sentences under mention as well. These sentences are not directly part of the flow of information. Instead they are tied to various channels of information flow by the ostension scheme. In this case, the input is not vacuous. Because they are under mention, their sigma variable remains unassigned. The tree of isolates in the input, however, has content, and this is due to their connection to an ostension scheme column.

Each row in an ostension scheme is a channel of information. Information flows along these channels in virtue of the pictures that introduce them. Information on each channel is a distinct spatio-temporal phenomenon, appearing as token. But information cannot be shared as token. It must be shared as type. The target language

consultant cashes out the information carried along each channel and in this way can recognize the information shared between check-marked rows for a column but not by rows without checkmarks. This recognition involves finding an isolate that constrains the source in each check-marked row in the same way. That isolate will serve as the lower bound for an isolate tree, the tree to appear as input for the elicited utterance. Therefore, unlike for cases of pure mention, although sigma remains an unassigned variable, it will be constrained – by an isolate tree. A sentence elicited for the column is to replicate the function of this isolate tree, to constrain the sigma variable in the same way.[17] The checks in a column thereby make the shared isolate tree from the input manifest to the user. The user can assume that the sentence replicates the constraints placed by the isolate tree. The input of the sentence is in this way externalized.

This is how ostension schemes address the indeterminacy problem at a basic level. The problem can now be said to arise because the isolate poset to be recovered from a single information channel is complex. The hearer cannot know which isolate from the range of possible isolates the speaker has chosen as the lower bound for the isolate tree in the sentence input. This is true even though the non-linguistic channel is manifest. A hearer would not know whether the input for *gavagai* were tree-THAT'S A RABBIT or tree-THAT'S A WHITE RABBIT or tree-THAT'S AN ANIMAL, even with a hopping white rabbit visible to both speaker and hearer. From a single such channel, no single isolate tree can be identified from the hearer's vantage point. Ostension schemes are designed to allow a single utterance to range over the sources of multiple rows. This allows a narrowing down of the set of possible isolate trees.

7. An Example

Language analysis with ostension schemes has two parts. First, there is access to the linguistic hierarchy at the level of the basis sentence. Following this, there is moving within the hierarchy. Comparing minimal sentences pairs is a way to move down the hierarchy.

I next present an ostension scheme displaying sentences from the Turkic language Sakha. The scheme presented is highly abbreviated. However, the pattern of check-marks on the scheme does suggest that the following sentences are minimal polarity pairs: (a) and (b), (c) and (d), and (e) and (f). The forms themselves suggest that (a), (c), and (e) should be a minimal triple, as should (b), (d) and (f). Sentences (a) through (f) appear to entail (g), and sentence (h) is a precization of (c) and (e).

Figure 4

	a.	b.	c.	d.	e.	f.	g.	h.
	✓		✓		✓		✓	✓
	✓			✓	✓		✓	
	✓		✓			✓	✓	
		✓	✓		✓		✓	✓
		✓	✓			✓	✓	
		✓		✓	✓		✓	
		✓		✓		✓	✓	
	tree-PERSON HAS GLASSES	tree-PERSON HAS NO GLASSES	tree-PERSON HAS MOUSTACHE	tree-PERSON HAS NO MOUS-TACHE	tree-PERSON HAS NOSE	tree-PERSON HAS NO NOSE	tree-THERE IS PERSON	tree-PERSON HAS NOSE AND MOUS-TACHE

I have identified a plausible tree for each column in the final row for clarity. This row is not found on a regular ostension scheme.

The following utterance, rendered as strings of phonemes, can be placed at the head of these columns.[18]

a. /kiniaʧʃikɯlaax/
b. /kiniaʧʃikɯtasuox/
c. /kinibɯtɯktaax/
d. /kinibɯtɯgasuox/

e. /kinimurunnɑɑx/
f. /kinimurunɑsuox/
g. /bukihi/
h. /kinimurunnaaxuonabɯtɯktɑɑx/

Starting with the comparison of (a), (b), and (d), a minimal triple, it is possible to isolate three non-overlapping parts: /ɑʃikɯ/, /bɯtɯk/, and /murun/. This is a first guess, since the sentences differ by /l/, /t/, and /n/ as well. Still, on this basis, the following constraints can be proposed.

Dep/ɑʃikɯ/$_x$: there are glasses in sigma in the role specified for x.
Dep/bɯtɯk/$_x$: there is a moustache in sigma in the role specified for x.
Dep/murun/$_x$: there is a nose in sigma in the role specified for x.

These constraints are lexical Dep constraints. They don't say, for example, that when there is a moustache, /bɯtɯk/ must be used. There is no mention of a moustache in (a), for example, a sentence checked for an input showing a moustache. But the constraints do say that if /bɯtɯk/ appears in the candidate, as it does in (c), it should correspond to a moustache-type entity or idea in the input. The constraint is a way of restricting sigma. Only source values containing a moustache-type entity can be entertained, given the occurrence of /bɯtɯk/ (provided that constraint is not out-ranked by a conflicting constraint).

The variable x represents a position within a syntactic tree or a morpheme-internal position. I assume these positions are associated with argument roles. An item appearing in that syntactic or morphological position will satisfy faithfulness if it corresponds to an entity in sigma plays the role in sigma specified for that position by the lexical entry.

/kini/ appears in most examples, and /kihi/ in a sentence which receives check-marks in every row. The following constraints can be proposed.

Dep/kini/$_x$: there is a person in sigma in the role specified for x.
Dep/kihi/$_x$: there is a person in sigma in the role specified for x.

Comparison of the minimal polarity pairs yields the following constraints for the final suffix.

Dep /$_{x,y}$LAAx/: y is attribute of the entity named in x in sigma.
Dep /$_{x\ y}$suox/: y is not attribute of the entity named in x in sigma.

Dep constraints work together. They allow that in /kinimurunnɑɑx/, /kini/ is faithful to the possessor in the input and /murun/ to the attribute possessed. The syntactic position of /naax/ provides a morphological position for /murun/. A grammar of Sakha will identify a role for each syntactic or morphological position. The constraints given here are obviously a first pass and would be subject to further revision.

A tableau for a sentence such as (g) can now be given.

(11)

input:	Tree-PERSON HAS MOUSTACHE σ	Dep /σ/	Dep/$_{x,y}$LAAx/	Dep/$_{x}$ $_{y}$suox/	Dep /kini/$_{x}$	Dep /kihi/$_{x}$	Dep /ɑʧikɯ/$_{x}$	Dep /bɯtɯk/$_{x}$	Dep /murun/$_{x}$
i.	/kiniɑʧikɯlɑɑx/ σ						*!		
ii.	/kinibɯtɯktɑɑx/ σ’	*!							
iii.	/kinibɯtɯktɑɑx/ σ ←								
iv.	/kinimurunnɑɑx/ σ								*!
v.	/bukihi/ σ								
vi.	/kinimurunnɑɑx uona bɯtɯktɑɑx/ σ								*!

The double line separates higher constraints from lower ones in the needed ordering. Candidate (i) is ruled out because it contains /ɑʧikɯ/ (‘glasses’) which is unsupported by the input. Candidate (ii) is ruled out because in it the sigma variable is not faithful to the input. Candidate (iv) is ruled out because it contains /murun/ (‘nose’) which is unsupported by the input. Candidate (vi) is ruled out because it contains /murunnɑɑxuonabɯtɯktɑɑx/ (‘has nose and has moustache’). The additional conjunct is not supported by the input. Neither Candidate (iii) (‘he has a moustache’) nor Candidate (v) (‘this is a person’) violate the Dep constraints. Between these, Candidate (iii) is the more restrictive and is chosen on that account.

The formulation of relevant constraints as Dep constraints captures the notion of information from a channel being carried along by a sentence. At the same time, the ostension scheme, with its identification of minimal sentence pairs, allows for the discovery of explanatory constraints. I am suggesting that learning a language, at least at a preliminary stage, can be seen as the discovery of such lexical and structural Dep constraints.

The constraints proposed represent the kinds of tentative hypotheses a user of the tableau would entertain. Such hypotheses can be informally stated as, for example, “/bɯtɯk/ must mean ‘moustache’”. This is in fact the kind of comment which is overheard as users work through the data on an ostension scheme. Such comments point directly to the kind of constraints that are in play in the language. The hypotheses will inevitably be checked against further data, or by directly asking speakers of the language, by consulting written grammars, and so on. In this case, such checking revealed that the word /kini/ is a singular third person pronoun, rather than a word for ‘person’.

A production tableau can be paired with an interpretation tableau. The interpretation tableau models how a hearer recovers the original input. To illustrate, I provide an interpretation tableau for the sentence /kinibɯtɯktɑɑx/, ‘he has a moustache.’

(12)

input:	/kinibɯtɯktɑɑx/ σ	Dep /σ/	Dep/$_{x,y}$ LAAx/	Dep/$_{x}$ $_{y}$suox/	Dep /kini/$_{x}$	Dep /kihi/$_{x}$	Dep /ɑʧikɯ/$_{x}$	Dep /bɯtɯk/$_{x}$	Dep /murun/$_{x}$
i.	Tree-PERSON HAS GLASSES σ		*					*!	
ii.	Tree-PERSON HAS MOUSTACHE σ'	*!							
iii.	Tree-PERSON HAS MOUSTACHE σ								
iv.	Tree-PERSON HAS NOSE σ							*!	
v.	Tree-PERSON HAS NOSE AND MOUSTACHE σ								

Because /bɯtɯk/ is in the input, Dep/ bɯtɯk/ requires candidates to make a similar restriction on sigma. Because /tɑɑx/ is associated first with /bɯtɯk/ and then with /kini/, Dep/tɑɑx/ requires candidates to restrict sigma to values in which a person has a moustache. Candidate (i) does not support this original input and neither does Candidate (iv). Candidate (ii) is not faithful to the sigma variable in the input. Candidate (iii) is not shown to incur violations and neither is Candidate (v). However, (iii) is the less restrictive of the two and will prevail in the competition.

This tableau shows the task of the hearer. On the basis of the uttered sentence, the original input is to be recovered. Possible inputs are now arrayed as candidates. Lexical items in the uttered sentence must receive support from these. The winner therefore should include a person with a moustache. However, there is no warrant for including a person with a nose as well, because nothing in the lexical or structural make-up of the sentences requires this. The hearer does not go beyond what is given in the original interpretation of the sentence.[19]

8. Fictitious Sources

Leaving aside ostension schemes, I turn now toward one more type of source for sigma, fictitious sources. The case of pure fiction differs in various ways from the case of misleading or false information. For misleading or false cases, the source variable sigma is filled in by an actual source. The speaker means the sentence to be taken as veridical. The variable is filled in independently of the isolate tree, the isolate tree being cashed out from the incoming disturbance. The disturbance itself, unlike sigma, comes not from the distant source but from an immediately proximate relay. It is quite possible that the disturbance no longer represents the source accurately, due to noise and distortion along the way. Furthermore, a speaker may decide to lie and misrepresent incoming information. Even a lie, however, purports to be about an actual source.

Fictitious uses of declarative sentences are a distinct case which may be of special importance because they point to a possible treatment for irrealis components of complex sentences. That topic I leave for future research. For now I want to point out that fictitious sources illustrate further the utility of two-part account of information developed here.

Veridical sentences and fictitious sentences have much in common. A person can read an account as true only to learn later that it is fiction. A person can read an account as fiction only to find out later it is true. A person can read an account not knowing if it is fiction or not, and even in the course of the reading go back and forth between thinking the account is real and thinking it is fiction. The same is true of overhearing a narrative.

Such cases show that it is not the language itself that establishes the status of the narrative or report.[20] The words and their syntactic relation are not understood differently in each scenario. The grammar of the language for each type of discourse is the same. These cases underscore the claim that sigma is a variable whose assignment is independent of the informational isolates associated with it or the language which encodes those isolates.[21]

In the sentence under mention cases, the variable is unassigned. In the veridical case, it is assigned an actual situation as its value. The fictitious case differs from both those cases. Note the fictitious use of language is constrained by a special set of licensing conventions. These conventions tend to be soft, rather than absolute. In general, the fictional nature of the production needs to be explicitly acknowledged (otherwise it counts not as fiction but as a falsehood). The status of the production as fictitious is manifest through its mode of release – as novel, short story, play, and so on. Various privileges and restrictions apply to the author. The author alone can say what is what (that Sherlock Holmes lived at 221B Baker Street), but anything left unsaid by the author (Holmes's actual height) is left unresolvable. (There is in fact a term used in film and literary studies to refer to just such 'things left unsaid' in fiction, *Unbestimmtheit*.[22]) Such conventions do require the author to be consistent and to not allow blatant contradictions into the work. There can be deliberate flouting of conventions, but the estimated patience of the audience is a factor that the writer will consider.

Given these conventions, it cannot be said that the sigma variable is unassigned, as it is in the mention cases. The variable does get a value. Dep constraints still constrain sigma and in this way constraint its value. But with fiction, there is no pushback from reality. Whatever a Dep constraint says, goes – as long as contradictions are (mostly) avoided. These constraints enable an author to create a world through the narrative. What is created is a value for sigma, a value that persists across sentences in the narrative, and a value that is updated by each successive sentence. The author controls the content with each new sentence, but in a non-reversible fashion. Once content is added, it is not easily removed. This value of the variable is a virtual value.

In discussing veridical sentences, I suggested that bringing sentence form to bear on sigma represents a level of predication more basic than the predication of a verb phrase to a subject, for example. This basic predication relates to the two-part theory of information I have been proposing. At the head of the information channel, a disturbance emanates from a source. A source variable accompanies the disturbance as it travels along the channel, passing through relays and arriving at the receiving end. There, the disturbance is cashed out as a set of isolates, constraining the source variable. This cashing out brings the independent components of information together. A sentence form is selected to replicate isolate constraints, while the sentence itself replicates sigma. Sentence form constraining sentence sigma is the fundamental predication of a sentence. But since the sentence is veridical, the predication is on an actual source. This is why a sentence is the unit of information in language. Through its form, a basic sentence constrains the source at the head of the information channel it belongs to. Properties of a possibly distant source are expressed in this way at the receiving end of the channel.

Since sigma is a variable, it can also take a virtual value. For this case, what does this deeper predication represent? A fictitious sentence has a form constraining its implicit sigma variable. There is no distant source whose properties are thereby expressed. Instead, the input to the sentence creates a new channel of information and serves as the head of that channel. Information is sent forth by utterance of the sentence, as in the veridical case, but unlike the veridical case, this information is just getting started.

I would claim that this arrangement represents a powerful innovation in language. By this innovation, imaginative thoughts can be expressed. These thoughts go out into the world with real-world effects. Virtual information competes with real information. But a further possibility arises, which is that virtual information created in this way can become a component of complex sentences, sentences whose interpretation involves an intensional aspect.

This is a topic for future investigation. The sentence-types elicited with ostension schemes in their present form are extensional. However, even extensional sentences can be used fictitiously. If the same mechanisms can explain veridical and fictitious sentences, this may point to a way to go beyond merely extensional sentences, provided that intensional language use has a connection to human imagination. Just as imagination creates new channels of information flow through fictitious sentences, so it might create channels that feed into sentences that go beyond what can be said about the here and now.

9. Theoretical Loose-Ends[23]

In this section I return to several outstanding issues, beginning with Quine's 'gavagai' scenario. The 'gavagai' example is meant to show that language is underdetermined, and underdetermined at multiple levels. At a simple level, the meaning 'rabbit' cannot be distinguished from 'animal' or 'white'. Ostension schemes dis-

tinguish sentences from their entailments (animal) as well as from their precizations (white rabbit) which in the general case can help resolve this level of indeterminancy. But Quine raises a more difficult case in suggesting that 'gavagai' might also mean a temporal stage of a rabbit, or 'sundry undetached parts of rabbits', or 'a recurring universal, rabbithood' (Quine, 1960: 28–29). By assuming that 'gavagai' just refers to a rabbit, Quine says, the linguist 'is just taking for granted that the native is enough like us to have a brief general term for rabbits and no brief general term for rabbit stages or parts' (Quine, 1960: 52). A worry is that ostension schemes would not be able to pick out any of these particular meanings, no matter how many additional rows are added to it. The novice could learn the meaning of 'gavagai' incorrectly, even while using term appropriately enough in all situations so as never to elicit a correction which would reveal its true meaning.

The linguist is not entitled to assume that the target language speaker is enough alike to carve up the world in the same way. But there is an assumption that the linguist is entitled to make, that the target language in question is learnable without translation. It may be possible to invent languages that do not have such a feature but any natural language is learned by children in the general case without direct instruction and without translation from a different language. Any such language is embedded in a physical and social environment, helping make this possible. But the language itself presumably contains design features to ensure its learnability, given such environments, human learning abilities, and so on. Without such design features, it can be supposed, the language simply would not be passed on.

One key such feature would surely be that differences in the extra-linguistic reality relevant to a speech community tend to be matched by differences in form. This matching is not absolute – languages can withstand a degree of homophony and polysemy – but beyond a certain limit morphological or syntactic innovations will be needed to create some level of distinction. Relevant distinctions in form are discovered precisely through Bloomfield's procedure of peeling out. Quine, citing linguists such as Firth and Pike as he does, undoubtedly was aware of the procedure, but in his discussion of 'gavagai' scenario he does not foreground it or the linguistic realities behind it. 'Gavagai' is discussed as an isolated linguistic item and not granted a place within a paradigm of related forms. This contributes to the impression that 'gavagai' could exist on its own without alternate or similar forms for related meanings. If there are such forms, they are in principle discoverable, and Quine's case for extreme under-determinacy is weakened.

But suppose that 'gavagai' is the only word relating to rabbits in the language, meaning either 'rabbit-stage', 'rabbit-hood', or 'assemblage of rabbit parts', with no other such concepts expressible. But this would only amount to 'a distinction without a difference' (Quine, 1960: 26). A novice concluding 'gavagai' can be used to describe a single rabbit hopping by has in such a case not reached a mistaken conclusion.

Or suppose that 'gavagai' is polysemous between these possible rabbit-related meanings. Additional examples would provide evidence of the polysemy of the

term, and there is no principled reason for the novice not to discover this. Such a level of polysemy is unlikely. In English the terms ‘rabbit-stage’, ‘rabbit-hood’, and ‘rabbit-parts’ are morphologically complex. This complexity is an aid to discovering their meaning, which as I said is presumably not an accident but part of what makes natural language transmittable across generations. Quine does concede that the language investigator, even ‘unaided by an interpreter’, and only on the basis of what the investigator ‘sees impinging on the native’s surfaces and … observable behavior’, can still end up with meanings or translations ‘of all possible native sentences’ (Quine, 1960: 28). This concession is made in the face of all the doubts he raises, but many of those doubts concern a linguistic item that has not been shown to be part of a language with design features that would help make it learnable.

Ostension schemes provide a counterpoint to the ‘gavagai’ scenario by introducing multiple information channels working in parallel. Information from a single source is rich and varied. An unknown linguistic utterance to capture the information passing along such a channel would be highly equivocal. Multiple channels working in parallel over which a linguistic utterance applies or fails to apply help reduce this equivocation. What no addition of information channels can do is make language discovery a deductive procedure. The language consultant as speaker, and the language novice as hearer, will make hypotheses as they proceed. A cooperative speaker will consider the situation from the hearer’s point of view, and the hearer from the speaker’s point of view. The hypotheses the hearer constructs will be tentative, subject to revision in the face of additional information. The point of an ostension scheme is to provide such information. The point of developing this general strategy is to discover to what degree the physical and social environment of a language learner can be reproduced and ultimately to discover what features of language design make learning in such environments possible.

A solution appealing to information channels raises the question of whether information is the kind of phenomenon that can be pre-linguistically sorted into discrete units. Ostension scheme elicitation and ostension presuppose that this can be done. If information does not lend itself to pre-linguistic quantizing, then either ostension scheme elicitation should be impossible, or ostension schemes do not rely on information flow. But ostension schemes do work, at least in the highly restricted sense I have pointed to. I take it as a truism that they rely on information flow. From this it follows that information can be pre-linguistically sorted into discrete units, a claim I have intended less to argue for than to demonstrate.

The use of information flow to clarify issues of underdeterminism in language is a novel aspect to my proposal, but it can be fairly asked whether my treatment of information in any way differs or goes beyond results in Dretske (1981) or Barwise (1989). I think the answer is that it does. An enduring puzzle concerning information has been that on the one hand information seems to be tied to the real world, and on the other, information can be false, misleading, or fictitious. Dretske avoids the problem by saying he is not concerned to legislate over colloquial uses of the term

'information' and that '*false* information and *mis*-information are not kinds of information' (Dretske, 1989: 45). But I observe that just as declarative sentences are not linguistically different whether they are true, false, or fictitious, false information is handled by receivers in the same way as correct information and the colloquial qualifications of 'reliable', 'true', or 'false' information point to an underlying unity. My proposal introduces a go-between for information, the variable sigma. On the one hand, information as a physical disturbance or linguistic utterance is cashed out to restrict sigma. On the other hand, sigma as a variable does or does not get a value from an actual source. This captures the flexibility of the concept in a way that conforms to common sense but which has eluded past treatments. Information structure as an explanatory mechanism in linguistics is concerned with different sets of issues, not issues dealing with true, false, or fictitious information or how linguistic expressions capture information flowing along a channel. I have attempted to tie my proposal with mainstream linguistic ideas, however, in my invocation of backwards looking Dep-like constraints. These constraints, restricting the sigma variable as they do, can account for false and fictitious information. They show clearly how meaning is involved in the linguistic transmission of information.

But looking to information flow to delineate meanings would seem to lead to other problems. In particular, expressions that do not obviously carry information (abstract language or interjections, for example) are not apparently amendable to ostensive definition. There is nothing in the world to point at to convey the meaning of 'counterfactual' or 'ouch!' From that observation, it might be concluded that such expressions cannot be involved in the flow of information and therefore the account of meaning I have given lacks generality.

It is simply false, however, that a word like 'counterfactual' cannot participate in the flow of information. A remark such as 'that's a counterfactual claim' clearly conveys the information that such-and-such an utterance is a counterfactual claim. An utterance of 'ouch' conveys the information that the speaker is experiencing actual or vicarious pain. The usual caveats apply – the speaker may be faking it, using the expression sarcastically, and so on. Analogous caveats apply to the utterance of an ordinary declarative sentence. But even granting that such expressions can participate in the flow of information, it is also true that their meaning cannot easily be conveyed by setting up non-linguistic channels of information. These expressions do not seem to have ostensive definitions.

My first response is that ostensive definitions are not identical to meaning in the account I am proposing. My account of meaning involves Dep-constraints. Dep-constraints are restrictions put on the value of a sigma in the input of an utterance. Words like 'counterfactual' or 'ouch' can fully participate in such restriction. The nature of some expressions lends itself to ostensive definition in an obvious way, while for others it does not. It is conceded that putting word and structural meaning in the form of Dep-constraints is not the last word on meaning, but the difficulty of imagining ostensive definitions for certain forms does not show a lack of generality for the approach to meaning.

With respect to Dep-constraints, it can fairly be asked why I appeal to OT at all, since I depart from the standard theory to the extent that I do. My explanation for ostension schemes depends on the notion of information flow, and information flow implies a direction. An observation sentence under use facilitates this forward, downstream flow of information. From the welter of information coming along a channel, the speaker chooses some aspect to express. The linguistic choices must faithfully represent this choice. Dep-constraints guarantee this faithfulness by working upstream against the flow of information. These constraints reach back to the interpretation of a non-linguistic input. Dep-constraints have a pride of place in the theory because they function along the edge where language meets non-language. These constraints were originally conceived to rule against vacuous additions of form and here I have generalized this to a requirement that words are chosen for a purpose. The change is substantial and the implications are many, but I claim only to be traveling along a path already initiated by recent work in bidirectional OT.

It is an interesting question how Dep-constraints for abstract and related expressions can be learned. I have just suggested that natural languages are implicitly learnable given appropriate physical and social contexts and that these languages are designed to enable this learning. Otherwise, they would simply disappear. But forms and their meanings have to be discoverable somehow. What are the design features that enable abstract words to be learned? I would hazard a guess that languages are organized to allow learners to build on what they already know. Language that has already been learned can interact with features of the physical and social context and allow new forms to be learned. This too would be a kind of ostension, where the pointing to extra-linguistic reality is done in part using the language itself. (Robinson's (1954) ostensive methods of definition does not exclude the use of language.) Whether this in itself would make abstract language discoverable remains to be seen. One eventual goal of this ostension scheme project is to investigate this possibility.

10. Concluding Statement

The account I have proposed brings out connections between practical linguistics and theory. Monolingual elicitation of language and ostension are basic to how language is learned and taught. Ostension schemes are designed to systematize these activities, which means that designing these schemes should bring to the fore aspects of human language. Because this work is new, it may even highlight previously under-represented features of language. Since ostension schemes involve language in connection to information flow, interactions between linguistic form, linguistic meaning, and information flow receive particular attention. I believe ostension schemes reveal these interactions in a particular concrete way. Beyond any practical advantage this study affords, value may come from the simple perspective on language that these schemes provide.

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Author Contributions
The author confirms being the sole contributor of this work and approved it for publication.

Conflict of Interest Statement
The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

NOTES

1. Sperber and Wilson (1986: 49) similarly raise the puzzle of how the audience of a linguistic utterance is to discover the message intended by the speaker. Toolan (1996) is skeptical of Sperber and Wilson's foundational principles, which include ostensiveness, and critiques the notion of *co-presence heuristics* of Clark and Marshall (1981), as cited in Gibbs (1987). Toolan states that 'It is the orientedness to searching for evidence, not the reliability of finding evidence, that underpins communication and understanding' (Toolan, 1996: 197–199). The joint behavior of speaker and hearer through the device of ostension schemes displays an orientedness to provide evidence and to search for it. The ostension scheme is a device over which speaker and hearer co-ordinate.

2. As per Grice (1989) or Sperber and Wilson (1986), relevance is a necessary part of communication but it can never be guaranteed, and this adds a further level of uncertainty to Quine's scenario. The intention to be relevant on the part of the language speaker would also be necessary for elicitation and ostension. Throughout this paper I will assume that the target language producers do not simply make random utterances.

3. Utterances, the sentences they represent, can be made indefinitely longer through coordination and other kinds of recursion. Without attempting to quantify information, I still assume that the quantity of information contained in a scene goes beyond what even lengthy sentences could convey.

4. It is controversial to say that information can be pre-linguistically isolated into units. Ostension schemes demonstrate how this can be done.

5. My attention here is focused on only one aspect of the indeterminacy problem, and quite likely the easiest. It is not my intention here to even try to address the whole range of issues underlying Quine's deeply skeptical position on linguistic meaning.

6. Information structure, especially in relation to discourse and intonation, is a current topic of investigation in linguistics, but the concept of information flow I appeal to can be traced back to such work as Shannon and Weaver (1949), Dretske (1981), and Barwise (1989).

7. See Harris and Hutton (2007) for a critique of Robinson's discussion.

8. See Gold (1967) and Kelly (1996) for discussion of learning or attaining knowledge in the limit.

9. I present this statement as a truism.

10. Although cashing out may involve cognitive processes, I choose to treat isolates and the sets they form as abstract entities rather than cognitive objects.

11. As an anonymous reviewer has pointed out, the view proposed here is akin to representationalism in philosophy, whereby a mental state is directed towards something different from itself, an intentional object or scene which itself may be real or unreal (Brentano (1874) as discussed in Jacob (2014)). In my proposal, the declarative sentence is directed away from itself, restricting possible values of a sigma variable as discussed further below. The veridicality of a sentence depends on the value given to that sigma.

12. Chierchia and McConnell-Ginet (1993: 11–12) discuss aboutness.

13. Given that sigma is a variable, one could say that the aboutness of a sentence is only a potential. If sigma gets an actual value, the sentence is about that actual source. One could also say that the sentence is about an intentional object, in keeping with representationalism. By that view, the intentional object or scene may either be real or not real (Relevant discussion is found in Lycan (2015)). In my view it would be less mysterious to call the object in the unreal case a de dicto object and distinguish it from the real, de re object.

14. Fragments will be assumed to be reduced sentences and carry with them a sigma. Complex sentences are not treated in this paper.

15. An obvious move to make in keeping with certain syntactic traditions would be to assign sigma as the lexical value of an abstract syntactic head. One such possibility would be the C head of a CP. Given the aims of this paper, I refrain from making such any such move.

16. It should be allowed that these Dep constraints can be satisfied through metonymy. Dep/dog/ might be satisfied by an incoming stimulus showing a figurine in the shape of a dog.

17. Nothing in this arrangement can force a speaker to faithfully reproduce the constraint placed on sigma by an isolate. I am assuming a cooperative speaker.

18. I deliberately do not provide glosses here in order to illustrate the discovery process.

19. I do not rule out further pragmatic inferences which go beyond the basic semantic interpretation.

20. There are languages that provide narrative marking to make this distinction in some cases.

21. I do not presume that encoding of meaning with Dep-constraints is in any way rigid. Speaker meanings, idiosyncratic meanings, and so on can be captured with Dep-constraints.

22. I owe the term and its definition and field of application to an anonymous reviewer.

23. I intertwine in this discussion my response to objections raised by several anonymous reviewers.

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Confusing Subjective with Objective Criteria of Correctness: A Philosophical Approach to the "Tip-of-the-Tongue" Phenomenon

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ABSTRACT. One of the most striking features of the so-called "tip-of-the-tongue" phenomenon (TOT) is that the finding of the sought-for word generates a kind of click or a feeling of fit between that word and an alleged mental mould of it. But from a philosophical standpoint, and taking as a reference Ludwig Wittgenstein's work, I argue that such clicking does not constitute any objective criterion of correctness – or fit – because it does not make it possible to distinguish between a correct click and one that simply seems right to the individual concerned. The click is therefore a merely subjective criterion that leads to an aesthetic reaction characterized by the immediacy and absence of doubt with which the individual accepts as correct the word that satisfies her. This argument is further supported when focus shifts from subjective or spontaneous TOTs to objective TOTs that are elicited in the laboratory, since, in this case, there can be no "correct clicks" because the expression "incorrect click" makes no sense. Lastly, I analyze the extent to which the standard use of the expression that "a word is on the tip of the tongue" and its neuroscientific use could be compatible with each other.

Keywords: tip-of-the-tongue state; Wittgenstein; criterion; aesthetics; language-game; compatibilism

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1. Introduction

We are all acquainted with the peculiar feeling of being on the verge of retrieving a very specific word that we know: in such cases, we are certain that we will identify the missing word as correct with no doubt whatsoever once it has been found.

Whoever is in this situation usually says that the sought-for word is on the tip of her tongue, so that this phenomenon is called "tip-of-the-tongue state" – hereafter, "TOT." These states have often been compared with feeling of knowing experiences – henceforth, "FOK". An FOK is a metacognitive state in which the individual is convinced that she will correctly recognize the missing response if it is seen or heard at a later point in time although it still cannot be recalled in the present moment.[1] A TOT is therefore very similar to an FOK; but unlike the FOK, the TOT is characterized by the feeling that the sought-after name will be recalled very soon. Although Hamberger and Seidel (2003) state that the TOT must last at least two seconds, it is true that, in some TOT cases, the word may take even some weeks to come out. Yet even though the retrieval is long delayed, the distinguishing feature of the TOT is that one feels, even for a long time, that the sought-for word will be recalled immediately. Hence, this feeling of imminence compels the individual to engage in the retrieval process (Litman et al., 2005). In this vein, Schwartz (2001) found out that people try to solve an unchallenged target longer if a TOT has occurred than if it has not happened. Keeping this in mind, Harley and MacAndrew (2014) define the TOT on the basis of three basic features: delay of the retrieval, feeling that the word will be imminently recalled, and effort to actively search for the missing word.

There are several reasons as to why TOT has often been the focus of research. To begin with, TOT seems to occur universally across different languages (Schwartz, 2002). It is also very noticeable that although the individual is unable to retrieve the sought-for word, "bits and pieces of it often come to mind" (Brown, 2012: 81). Furthermore, TOTs are fascinating inasmuch as they reveal how unreliable our knowledge base seems to be, for they concern bits of information that were easily accessed time and again, so that such bits are expected to be deeply engraved in our memory. In this sense, "having a TOT on a well-known word feels like getting an error code from the computer on a routine operation" (Brown and Caderao, 2014: 32). Keeping these traits in mind, it should come as no surprise that TOTs have been analyzed from very different standpoints and in relation to many issues. Indeed, TOTs have been investigated in bilinguals (Kreiner & Degani, 2015; Gollan et al., 2014), by comparing peoples of different ages (Huijbers et al., 2017; Lee & Choi, 2016; Navarrete et al., 2015; Shafto et al., 2017; Theocharopoulou et al., 2015), and using electroencephalography registration (Kozlovskiy et al., 2017; Resnik et al., 2014). Moreover, researchers have focused on the way TOTs are influenced by, among other things, memory (Bloom et al., 2018; Stavraki et al., 2017), reasoning (Cleary & Claxton, 2015), implicit learning (D'Angelo & Humphreys, 2015), curiosity (Metcalfe et al., 2017), word length (Pureza et al., 2016), evaluative observation (James et al., 2018), and free report instructions (Jersakova et al., 2016). By the way, scientific research on TOT began by using definitions of infrequently used words to generate TOTs in the laboratory. Schwartz and Metcalfe (2014) and Brown (2012) regard this seminal trend as a clear exponent of what they call *direct access view*, according to which the missing word triggers the TOT but has not

sufficient activation to trigger recall because there is something that prevents the target word from being retrieved. Nevertheless, the main predecessor of the direct access view is William James, who, at the end of the 19th century, made reference to the cognitive gap that prevents us from accessing the sought-for word:

> Suppose we try to recall a forgotten name. The state of our consciousness is peculiar. There is a gap therein; but no mere gap. It is a gap that is intensively active. A sort of wraith of the name is in it, beckoning us in a given direction, making us at moments tingle with the sense of our closeness, and then letting us sink back without the longed-for term. If wrong names are proposed to us, this singularly definite gap acts immediately so as to negate them. They do not fit into its mould. And the gap of one word does not feel like the gap of another, all empty of content as both might seem necessarily to be when described as gaps (James, 1893: 163).

There are two closely related reasons as to why I am particularly interested in the idea of the mould in which the missing word must fit. On the one hand, the finding of this word seems to generate a kind of click – or a peculiar feeling of fit – that may lead us to think that there really *exists* a hidden mechanism in which a word has fit in a mould. On the other hand, this intuition seems to lie at the basis of the main research lines on TOTs − including the *direct access view* mentioned above. In this vein, it can even be assumed that, if the TOT's mechanism were known in detail, it should be possible to verify whether the word accepted by the experiencer is the one which fits in the mould, thus leaving margin for the possibility of a mistake or incorrect click.

In this paper, however, I intend to show that this is a misunderstanding largely due to the tendency to think that criteria of correctness *must* be objective. Thus, I will analyze the consequences of considering TOT as a phenomenon based on an objective criterion of correctness, from which it will automatically follow that this criterion is subjective. To this end, I will take as a basis the later work of Ludwig Wittgenstein, who had a deep knowledge of William James' *The Principles of Psychology*. Specifically, Section 2 will focus on the subjective or spontaneous TOT in order to explain why the click does not constitute an objective criterion of correctness that makes it possible to verify whether the word which provoked such feeling really fits into an alleged mould. In Section 3, I will explain why the click is also a merely subjective criterion of correctness in the case of objective TOTs that are elicited in the laboratory. Lastly, Section 4 analyzes the extent to which the standard use of the expression that "a word is on the tip of the tongue" and its neuroscientific use could be compatible with each other.

2. TOT as Aesthetic Reaction

The Spanish cellist Pablo Casals told his pupils that each one of Johann Sebastian Bach's solo cello Suites acquires its distinctive character from its respective prelude.

Thus, the adjectives used by Casals to characterize each of the six Suites were: No. 1 "optimistic," No. 2 "tragic," No. 3 "heroic," No. 4 "grandiose," No. 5 "tempestuous," and No. 6 "bucolic." Nevertheless, Mstislav Rostropovich disagreed with Casals' characterization of the Suite No. 5. According to Rostropovich, the best adjective to describe this Suite was not "tempestuous"·but "eternal," as the Azerbaijani cellist held throughout his life that eternity itself will be experienced if such suite is performed following strictly and rigorously Bach's score. Even though one is not a musical genius of the caliber of Casals or Rostropovich, one can state that, in her opinion, the best word to characterize Bach's solo cello Suite No. 5 is neither "tempestuous" nor "eternal," but a different one: let us imagine that this individual, whom we will call A, says that the word that best describes the character of the mentioned Suite is on the tip of her tongue. Another subject whom we will call B, taking A's remarks as a lead, might ask her: "Is 'deaf' the word you are looking for?" This question might be followed by a dialogue as peculiar as the following one:

A: No, that word falls heavily and randomly, without being aware of its course.
B: Then, might it be "aching"?
A: No, "aching" does not necessarily take any blame, whereas the word that is on the tip of my tongue is filled with guilt.

Since the connotations provided by A do not have to be shared by other people, B might find it bizarre to associate the word "aching" with the sense of guilt. Furthermore, B could think that he has come increasingly closer to the missing word, but A is the only person who can really confirm if each word is more or less appropriate – and in which sense – to the extent that A is also the only person who can ensure that the search has been successfully completed. In that case, B might note that some remark made by A was rather misleading or even incompatible with the word that A has finally accepted, yet B cannot conclude that A has not adequately recognized the missing word. Perhaps some remark was ambiguous; but if B is acquainted with what we mean when saying that a word is "on the tip of the tongue," he will not be able to dispute that it is A who determines whether the target word has been correctly identified. By way of example, A could state that the word she was searching for is "penitent," and could also add that she has felt the click characteristic of TOT's resolution process. Then, B might reply that "aching" fits better with A's indications. Nevertheless, it would be absurd for B to insist that "aching" should cause A an even better or clearer click than the one provoked by the adjective "penitent." As I have just said, the only person who can ensure that the search process has been successfully carried out is A, and regardless of how dogmatic and irrational this requirement may seem, it is a fundamental feature of the TOT language-game.[2]

In this case, we might be tempted to think that the missing word should fit into its own mould, thereby causing a feeling similar to a click which, in turn, would undeniably indicate that the search has been successfully completed. The following

example, however, will show that this idea is wrong. A psychological experiment might consist in pressing a key just when two lines which counter-rotate seem to form only one line. At first sight, we may think that it would be very likely to make mistakes when indicating the precise moment in which two lines appear as continuous, while there is no room for error when we must find out the only word that can fit into its own mould. In the first case, it is required to point at a very concrete point or moment within a continuum, whilst in the second case there is a hidden word and it simply has to be discovered. Though we are strongly inclined to believe that in the last case it can be distinguished with far greater security whether a given attempt at settlement is correct, quite the opposite is true. Indeed, it is possible to ascertain with great precision if we have pointed at the precise moment in which the two lines formed only one line: to this end, it would be enough to compare two temporary variables, i.e. the moment in which the key is pressed and the moment in which the two lines appear as continuous. Conversely, it is impossible to verify whether the word which has finally been accepted in a TOT – by causing a click – was previously hidden in our mind, so to say, waiting to be discovered, as there is no reliable criterion to confirm that both words are one and the same. It is irrelevant that A constantly repeats that the word that was on the tip of her tongue is just the word she identified as correct, nor would it be relevant that B changed his opinion to the extent of acknowledging that A's remarks and indications pointed unequivocally at the word she accepted. Leaving aside B's opinion – which, just like any other opinion, might be questioned and even changed shortly after – A's testimony would be at most an inner or private criterion that could not give rise to an objective verification. Hence, not even A can distinguish between a correct click and one that simply seems right to her. As Wittgenstein (1986: §258) pointed out regarding the identification of private objects, an objective "criterion of correctness" entails being able to objectively distinguish between what is right and what merely seems right to someone. For if such distinction cannot be made, whatever is going to seem right to the individual concerned will be right, so that, strictly speaking, we cannot talk here about "right." Thus, we find a tension here. On the one hand, the experiencer's judgments are essential for the TOT language-game; but, on the other hand, they constitute no objective criterion of correctness. Before digging deeper into this tension, we should pay attention to Wittgenstein's remarks on music and the TOT phenomenon itself.

If we pay attention to what Wittgenstein said regarding the TOT, we will realize that his few remarks on this issue are baffling. After all, TOT has been usually investigated within disciplines like psycholinguistics and cognitive neuroscience, but he describes it as an aesthetic question. To understand this striking change of perspective, it is necessary to begin by clarifying what Wittgenstein means when he states that "understanding a sentence is much more akin to understanding a theme in music than one may think" (1986: §527). As is well known, Wittgenstein quoted Goethe when saying "In the beginning was the deed" (1984: 31; 1997: §402). In this way, Wittgenstein invites us to contemplate language as something

that emerges not from logic or thinking, but from spontaneous reactions. Against the philosophical trend of considering logic as context-independent and prevailing in all possible worlds, Wittgenstein subjects traditional logic to a human form of life that generates its own and peculiar logic. It is not in vain that, unlike the merely reproductive character of some composers like Mendelssohn, Wittgenstein (1984) places particular value on the primitive impulses of the original artist of genius that lay at the heart of great art. In this sense, Wittgenstein (1980: §468) points out that "expressive playing" is not anything that accompanies the playing, but something that is understood once "someone is brought up in a particular culture – and then reacts to music in such-and-such a way." If this way of reacting could be explicitly learnt through rules, it would be a kind of pretense or mere accompaniment of the performance; yet expressive playing arises out directly of music. It is a way of reacting shared by those people who understand music, which leads to a sort of communication without rules. The fact that one understands music does not mean that she is able to decipher and put into words the alleged message hidden inside of a piece of music. Far from such a thing, our understanding of music resembles our understanding of gestures and the way we spontaneously react to them.

Admittedly, when we think of how a foreign language should be learnt, we often believe that we must acquire a large amount of vocabulary in order to transmit information; but we often forget that language can also be used for expressive purposes. The click or feeling of fit is a clear example of this:

> 1. Various things are suggested; one thing, as you say, clicks. What does it mean it "clicks"? Does it do anything you can compare to the noise of a click? Is there the ringing of a bell, or something comparable?
> 2. It is as though you needed some criterion, namely the ringing of a bell, to know the right thing has happened.
> 3. (…) You say: "That explanation is the right one which clicks." Suppose someone said: "The tempo of that song will be all right when I can hear distinctly such and such".
> 4. I have pointed to a phenomenon which, if it is the case, will make me satisfied (Wittgenstein 2007: 19).

In this case, Wittgenstein would regard as incorrect – or invalid for his purpose – all those performances of the song that do not allow him to hear what he wanted to hear. But even though he finally heard the expected nuance, there would not be any sort of click or fit: he would simply have heard what he wished to hear, and would therefore be satisfied. It is expected that other people who understand music are also able to perceive that nuance and thus become satisfied; but someone might disagree and deny that a given performance of the song provides the required nuance. However, there will be no room here for a rational dispute about whether the musician has really generated the nuance. It will simply be something that is either perceived or not, in a similar way as pain that is either experienced or not. Better still, it is just something that is regarded as valid or satisfactory. This aspect is fundamental for understanding Wittgenstein's conception of aesthetic explanations:

> People often say that aesthetics is a branch of psychology. The idea is that once we are more advanced, everything – all the mysteries of Art – will be understood by psychological experiments. Exceedingly stupid as the idea is, this is roughly it.
>
> Aesthetic questions have nothing to do with psychological experiments, but are answered in an entirely different way.
>
> (…) We could say that aesthetic explanation is not causal explanation. Or that it is causal explanation of this sort: that the person who agrees with you sees the cause at once.
>
> (…) An entirely new account of a correct explanation. Not one agreeing with experience, but one accepted. You have to give the explanation that is accepted (Wittgenstein, 2007: 17–18).

Wittgenstein was not opposed to science but to the interference from science in issues that it tries to explain with inadequate resources. Many people think that science is nowadays unable to account for diverse questions because it has not yet achieved the necessary degree of development, but Wittgenstein does not believe that this inability is always due to a development problem. From Wittgenstein's standpoint, it is a serious error to try to make science in realms that are not accessible to science. A clear example of this can be found, in his opinion, in aesthetic reactions. It may be tempting to think that, if we discovered the mental mechanism that allegedly explains the aesthetic reaction, we would then have found the explanation that really agrees with experience. But what matters here is that the individual accepts what is offered to her regardless of whether scientists endorse its validity. According to Glock (1996: 34), ordinary aesthetic explanations "explain our reactions through enhancing our understanding of the work itself." Indeed, these explanations reveal either the object or the reasons of our aesthetic reactions, but there are no objective criteria to ensure that such explanations are correct. Instead, they are accepted by an individual at a particular moment in time because then she finds them satisfactory. It is therefore not surprising that ordinary aesthetic explanations are often descriptive. After all, they do not unveil causes or hidden mechanisms, but describe how we cope with diverse situations when an aesthetic reaction takes place. An example of this can be found in Wittgenstein's explanation of the TOT:

> "The word is on the tip of my tongue." What is going on in my consciousness? That is not the point at all. Whatever did go on was not what was meant by that expression. It is of more interest what went on in my behaviour.–"The word is on the tip of my tongue" tells you: the word which belongs here has escaped me, but I hope to find it soon. For the rest the verbal expression does no more than certain wordless behaviour (Wittgenstein, 1986: 219).

This description may seem rather succinct, but Wittgenstein uses it to emphasize the immediate nature of the reactions provoked by the TOT. In fact, this brief description shows some similarity to others such as "*This* is how calculation is

done" (1997: §§39, 47), "*this* is how we calculate" (1997: §212), "This is how we acquire conviction" (1997: §294), "This is how I act" (1997: §148), "This language-game just *is* like that" (1997: §56), "Any 'reasonable' person behaves like *this*" (1997: §254), etc. As Ariso (2015, 2016) noted, Wittgenstein (1997: §§110, 204) uses this kind of expressions of a seemingly dogmatic nature so that we cease looking for chains of justifications and explanations of hidden processes, for we should instead pay attention to the ungrounded ways of acting that lay at the bottom of our language-games. As seen at the beginning of this Section, neither does A doubt which the missing word is once it is found, nor does B place into question that it is A who determines if that was really the sought-for word. This agreement in showing no signs of doubt is a very significant trait of the TOT language-game, to the extent that it is also what allows A and B to communicate with one another when they try finding the word that is on the tip of A's tongue.

3. Implications of Objective TOTs

The view of the TOT that I have just shown may be difficult to accept because it seems to suffer from one important shortcoming: indeed, it could be argued that Wittgenstein eludes a complex issue by shifting our attention to merely aesthetic questions. To analyze this question, and unlike the last Section, I will refer not to the subjective or spontaneous TOT but to the objective ones that are induced in experimental settings, so that "the word the person in the TOT state is searching for must be the target the experimenter has in mind" (Harley & MacAndrew, 2014: 95). Let us begin with the analysis.

In order for the click to be regarded as an objective criterion of correctness, we should be in a position to objectively check which word is on the tip of the tongue from the beginning to the resolution of the TOT.[3] Furthermore, it should be possible to discover some sort of mechanism or connection between the click and the finding of the missing word, thereby proving that the click is experienced only when the mentioned finding takes place. As of today, none of these aims has been achieved by science. But let us suppose that scientists stated in the future that they were already able to clearly discern which words are on the tip of our tongues. Let us also imagine that people who experience a TOT always acknowledged that the word suggested by experimenters was just the one they were looking for. If we considered these cases as "correct clicks," we might take for granted that the words indicated by the scientists would constitute an objective criterion of correctness. Nevertheless, such an idea would be wrong because what matters is not achieving a large number of correct clicks, but proving that there can be no incorrect clicks. Yet if we try to pinpoint what is meant by "incorrect click," we are led to a paradoxical situation. Admittedly, the incorrect click would take place when the word indicated by the scientists was different from the one which, according to the individual concerned, caused the click. Therefore, if I say that the word that made me experience the click is *x* but add that I must be wrong because the word which should provoke

the click, according to the scientists, is *y*, I will have ceased to take part in our ordinary TOT language-game at least temporarily. Put in another way: if I hold on to our current use of language and reaffirm that the word that made me feel the click is *x* instead of *y*, I could not be wrong because the role played by the click within the TOT language-game is not related to the objective testing of a judgment, as it is confined to being a spontaneous expression. The criterion of correctness in this language-game, such as we play it, is not objective but *subjective*.[4] This does not mean that the language-game is deficient or incomplete: that is just how it is, or rather, that is how we play it. Hence, a click cannot be considered wrong because the reference to an "incorrect click" would already involve playing a different language-game: in other words, it would entail the imposition of a criterion – i.e. the scientist's indication – that dictates which word should cause the click even though it does not really provoke it. The consequence of such imposition would not be the objective elucidation of the missing word that must resolve the TOT, but the creation of a *parallel* practice originated from the confusion of a subjective criterion with an objective one. It can thus be concluded that, as the concept of "incorrect click" does not make sense, there is no point in talking about "correct clicks" either. As a result, the TOT does not allow any objective verification: all we can say about this language-game is that an individual thinks he has found the word that, according to him, was on the tip of his tongue, and no one disputes it. Since it is impossible to establish if he has really discovered the word that was allegedly hidden in his mind, it can simply be stated that he is satisfied with his finding.

To illustrate with a further example this confusion between subjective and objective criteria within scientific research, I would like to briefly bring up a similar case related to dream recording. Over half a century ago, Malcolm (1959) generated a heated debate when he argued that, since it cannot be verified whether a dream account corresponds to the relevant dream, the criterion of someone having had a dream is not dream-remembering, but dream-telling. However, Dennett (1977) replied that scientists of the future will surely be able to translate nervous-system activity into a detailed dream narrative. During the next decades, researchers made interesting progress in attempting to make real Dennett's prediction. First, Cerf et al. (2010) found that when an individual thinks about a specific image, a concrete group of neurons lights up: hence, by hooking up these neurons to a brain-machine interface, an image is called up on a computer screen. In this way, Cerf could read the individual's mind by checking which neuron lit up and when. On this basis, his aim is to develop a device to record dreams. In a similar vein, Horikawa et al. (2013) asked three subjects to fall asleep inside an fMRI machine: each of them was suddenly woken up nearly 200 times to recall what he was dreaming about. Subsequently, these scientists realized that some types of objects which appeared in the individuals' dreams might be correlated with brain patterns recorded through fMRI scans. The next step was to look for images that matched the objects found in the subjects' dream using an internet search engine: this information was then entered into a learning algorithm that assembled videos from the internet images,

so that a movie was created to represent each dream. This led Horikawa et al. (2013: 639) to conclude they had demonstrated how specific visual experience during sleep can be represented by brain activity patterns shared by stimulus perception, thereby "providing a means to uncover subjective contents of dreaming using objective neural measurement." As we can see, these scientists assure they reveal subjective contents of dreaming through objective measurement, so that they have already created a conceptual framework to elucidate those cases in which the subject's dream narrative does not match the movie developed by them: in such a case, the individual will have misremembered a dream because objective neural measurement indicates so. Yet scientists would then also have imposed a new criterion whose consequence would be the creation of a *parallel* practice originated from the confusion of a subjective criterion with an objective one.

Let us again focus on the objective TOTs that, for decades, have been elicited in the laboratory. Objective TOTs have been generated in different ways. To begin with, researchers used definitions of words of relatively low frequency. More recently, Maril et al. (2001) and Maril et al. (2005) presented participants with general information questions in the form of pairs of semantic cues – for instance, and among many others, "Carmen + composer," "Iraq + capital" – and asked them to recall the word that matched each pair of words – in these cases, "Bizet" and "Baghdad." A similar variant was chosen by Kikyo et al. (2001), who asked participants to answer as soon as possible questions about famous people – e.g., "Who established Sony?" In cases like these, the participant typically agrees with the experimenter regarding which the sought-for word is; but despite appearances, the words – or just the word – both of them refer to are derived from different criteria. Indeed, the experimenter follows an objective criterion, whilst the participant is confined to a subjective one. Specifically, the experimenter takes as a reference the true answer which corresponds to the word that the participant should discover, yet the latter simply looks for the word that makes him feel satisfied or convinced that the search has successfully ended. It should therefore come as no surprise that there are cases in which the experimenter and the participant do not *agree* regarding what the missing word is. Koriat (2012) warned that many participants, when asked "what is the capital of New Zealand?", may experience a TOT directed incorrectly not at the name "Wellington", but "Auckland." It is true that false answers are the exception rather than the rule, but they reveal a key point: what fuels the TOT is what the participant *believes* and not what the experimenter *knows*. It might be objected that this happens only when the participant's answer is wrong; yet, in principle, the experimenter cannot know whether the participant is orienting herself at a given moment by taking an incorrect answer as reference. Hence, objective TOTs involve two different practices even though they usually seem to be one and the same.

4. Conclusion

It has been argued that if scientists indicated which word is fueling a given TOT, that would entail the introduction of an objective criterion in a practice or language-game characterized by following a subjective criterion. Since there is no objective criterion that allows us to ensure the existence of a missing word hidden in our mind, it is appropriate to describe the resolution of the TOT as an aesthetic reaction. Stated otherwise, the target word cannot be identified until the individual concerned says which one it is. In this case, the problem is not restricted to a technological challenge that will be overcome sooner or later, for such problem involves a logical – or in Wittgenstein's terms, a grammatical – impossibility. It could be a technological challenge if the task of the scientists concerned the standard practice of the TOT, yet these are two different though parallel practices. As they are two different language-games, the introduction of an objective criterion in the daily practice would result in accepting that the sought-for word which fuels the TOT should be the one dictated by scientists regardless of whether that word really coincides with the term accepted by the individual who experiences the TOT.

Nonetheless, it would be interesting to reflect on the impact in our daily life of the neuroscientific concept of the TOT. Let us thus suppose, once again, that scientists announced the development of a procedure for revealing which is the missing word that fuels each TOT. In such a case, the standard expression that a word "is on the tip of the tongue" might seem to be exposed to the risk of incompatibilism, according to which a number of concepts of folk psychology could not live on in co-existence with neuroscientific progress. Yet, in my opinion, here there may be some room for compatibilism. To delve into this idea, I will bring up the two ways in which, according to Klagge (1989), compatibilism between neuroscientific progress and the concepts of folk psychology could happen. On the one hand, the impact of neuroscientific advances could be restricted to the scientific practice of neuroscience, without finding its way into ordinary language. On the other hand, the influence of neuroscientific progress on ordinary thinking might take place by supplementing – instead of by simply supplanting – folk psychology. The way I see it, the first option might be viable if the neuroscientific and the ordinary TOT language-game were played completely independently of each other, as interferences could be problematic. By way of example, if the neuroscientist stated that the word which really fuels a TOT is not the one indicated by the individual but a different one, the scientist should then explain how this confusion arose – i.e. why the subject believes that her TOT is fuelled by what we might call an "intrusive word." But no matter how sound this explanation may be, the individual could continue affirming that the sought-for word in her TOT – that is, the term which satisfies her – is the one she indicates instead of the one provided by the scientist. With respect to the second option, it might occur if both concepts would exist in each person for different purposes. Indeed, the ordinary concept could be used as is customary, whilst the neuroscientific one might be employed in very specific cases. For instance, a writer who experiences a TOT might wish to know a word alternative

to that which resolved her TOT, as she could then choose the best term for a given sentence. Perhaps it might also be used by a psychoanalyst who was interested in knowing whether the concept that fuelled her patient's TOT was really the one he indicated. As can be seen, the neuroscientific concept of TOT would give rise either to a parallel practice distant from the standard one, or to very scarce and anecdotal uses in our daily life. It is obvious that the investigation procedure could generate new knowledge and technological breakthroughs in the field of neuroscience; but irrespective of these developments and the use that were made of the neuroscientific concept of TOT in our everyday life, scientists should wonder if they were investigating either what we usually call "tip-of-the-tongue" phenomenon or a different issue.

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NOTES

1. By way of example, someone might state that even though she feels nothing that could lead her to think that she will remember the name of the Spanish Prime Minister neither at that moment nor surely later, she is convinced that she would be able to recognize it if she sees or hears it later.

2. According to Wittgenstein (1986: §7), a language-game is "the whole, consisting of language and the actions into which it is woven." There are countless language-games, e.g. "Giving orders, and obeying them," "Reporting an event," etc. (Wittgenstein, 1986: §23).

3. I have alluded to this time interval in order to exclude the possibility that the missing word could vary without the individual being aware of such change.

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Teacher Cognition about Sources of English as a Foreign Language (EFL) Listening Anxiety: A Qualitative Study

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ABSTRACT. The anxiety that accompanies English-as-a-foreign-language (EFL) listening comprehension is difficult to detect and access. Such anxiety will prevent the students from actively and strategically participating in the listening process. This qualitative study aims to explore teachers' cognitions about the sources of students' anxiety during their EFL listening in the classroom in a Chinese tertiary context. The participants' cognitions were elicited through in-depth pre-observation interviews, consecutive classroom observations for one semester, and stimulated recall interviews after each classroom observation. The study found that 16 sources organized into four categories contributed to EFL listening anxiety, among which students' unfamiliarity with cultural backgrounds and topics in the category of input played a prominent role. Pedagogical implications for reducing EFL listening anxiety are also discussed.

Keywords: English as a Foreign Language; teacher cognition;
foreign language listening anxiety (FLLA)

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Introduction

In the field of foreign language teaching and learning, listening has been taken as a core concept in the language acquisition process (Asher, 1969; James, 1982) and one of the most frequently used language skills in the classroom. Listening is an inseparable part of learning as it serves as a primary channel for learning (Field, 2008; Goh, 2019). However, listening is a term difficult to define because it is a "transient and invisible process that cannot be observed directly" (Rost, 2011: 1). From simply defined as "the activity of paying attention to and trying to get meaning from something we hear" (Underwood, 1989: 1) to a fairly complex "active and dynamic process of attending, perceiving, interpreting, remembering, and responding to the expressed (verbal and nonverbal) needs, concerns, and information offered by other human beings" (Purdy, 1997: 8), listening is reasonably conceived as "a bundle of related processes – recognitions of the sounds uttered by the speaker, perception of intonation patterns showing information focus, interpretation of the relevance of what is being said to the current topic and so on" (Mendelsohn & Lynch, 2013: 190).

Within the context of mainland China, as English learning is a heavily examination-oriented system in both high schools and universities, the teaching of English emphasizes the students' memorization of the prescribed content such as grammar and vocabulary (Yu, 2006), and the students' ability to listen and speak English is rarely fairly assessed, if at all. College students, especially English majors, in their early university years find themselves experiencing anxiety in the EFL listening course, as it is a skill that teachers have not been concerned with and developed. Vivid evidence of the students' anxiety includes their being quiet in class, avoiding eye contact with the teacher, crouching in the last row, and freezing up when called to answer questions, etc. (Tsui, 1996). As an important and compulsory course listed in the curriculum for English majors in Chinese universities, EFL listening is deemed a very, if not the most, difficult language skill, while the present situation of teaching EFL listening in the classroom is far from satisfactory. Both teachers and students of EFL listening courses are not satisfied with the learning outcome when they compare it against the effort they have made in the teaching and learning process. Therefore, it is high time that the tension arising from EFL listening classes be addressed and the significance of research on EFL listening anxiety be highlighted so that research findings will help us illuminate the challenges teachers and students face.

Exploring teacher cognition about the sources of EFL listening anxiety has its special significance. Teachers are regarded as thinking beings rather than teaching machines or technicians of teaching, and teaching is thus viewed as the realization of teachers' thought processes. Teachers' personal perceptions about teaching and learning are assumed to guide their decision-making during classroom teaching and thus shape their teaching practice. The present study is expected to provide pedagogical advice for teachers' future classroom teaching of EFL listening, which may eventually improve students' language proficiency and overall learning out-

comes in the course. The present study digs deep into how the EFL listening teachers identify and perceive the sources of EFL listening anxiety, which is pivotal for their efficient classroom teaching for enhancing student learning.

2. Literature Review

2.1 EFL Listening Anxiety

EFL listening is viewed as "a process of constructing meaning based on multi-dimensional relationships between the learner and all of the internal and external influences and the intrinsic and extrinsic elements involved in that learner's reality" (Vogely, 1995: 43). The effective learning of EFL listening is affected by many factors, and the influence of anxiety is one of such factors. Dörnyei & Skehan (2003) found that individual difference variables such as aptitude, motivation, emotion, and learning strategies are influential factors in foreign language learning. Among these variables, anxiety seems to bear an extremely important influence (Arnold, 1999; Gregersen, 2005; Horwitz, 2010; Oxford, 1999). Developed by Horwitz et al. (1986), the Foreign Language Classroom Anxiety Scale (FLCAS) taps into general foreign language anxiety in terms of communication apprehension, test anxiety, and fear of negative evaluation. The FLCAS has been widely applied by researchers and teachers alike to obtain information from students about their anxiety in foreign language learning (Horwitz, 2010; Zhang, 2001) Listening anxiety as a situation-specific language learning affect has also been investigated. It was first established by Elkhafaifi (2005) as a situation where learners experience fear and nervousness in a foreign language when they are expected to understand what is said to be part of the learning process. Empirical research has also been conducted. For example, Kimura (2008) investigated foreign language listening anxiety among 452 Japanese learners of English and found three factors of anxiety: Emotionality, worry, and anticipatory fear. The conclusion is that anxiety in EFL listening is specific to its situation.

A better understanding of situation-specific anxiety can be achieved through a comparison among the three main categories of anxiety: Trait anxiety, state anxiety, and situation-specific anxiety. People with trait anxiety have a continual tendency to feel anxious under a variety of situations (Spielberger, 1983), while situation-specific anxiety focuses on one single anxiety (MacIntyre & Gardner, 1991). Trait anxiety is generally stable over time and does not have strong fluctuation; situation-specific anxiety has the possibility of being affected by negative emotions (MacIntyre and Gardner, 1989, 1991). Different from trait anxiety and situation-specific anxiety which refer to the tendency to be anxious, state anxiety embodies such actual feelings of anxiety as nervousness, discomfort, and uneasiness at a particular point in time (Spielberger, 1983). Situation-specific anxiety cannot be separable from state anxiety as they are both happening in a certain situation and state anxiety can develop into situation-specific anxiety. For example, a student experiences anxiety in EFL listening as a result of poor performance in the class-

room (state anxiety). If experiencing anxiety repeatedly, the student tends to form a solid anxiety in such situations. In other words, the student's state anxiety develops into situation-specific anxiety.

EFL listening anxiety can be specific to various situations where EFL listening is performed, such as EFL listening tests, bidirectional conversations, and unidirectional listening. EFL listening tests are a typical situation where students experience anxiety under the influence of many factors such as the fear of failure. In bidirectional conversations, students' anxiety varies on the basis of their prediction of what to be said. The unidirectional listening in EFL is central to the discussion of this paper, as it is the main form of EFL listening for English majors in Chinese universities. In the unidirectional listening, the listener "has no chance to interrupt the speaker and asks for repetition or clarification" (Graham et al., 2014: 45). Examples of unidirectional listening of EFL listening include listening to English radio broadcast, an English passage, or an English dialogue.

The causal relationship between anxiety in unidirectional EFL listening and EFL listening performance has not been well explored empirically and researchers have not reached consensus. Sparks et al. (1991; 1996; 2000) hold that anxiety in foreign language learning is the consequence of low performance and further speculate that foreign language anxiety is a consequence of cognitive deficits rather than a cause of poor performance. MacIntyre (1995b) and Horwitz (2000) argue that anxiety can be a source of diminished performance among foreign language learners, maintaining that foreign language anxiety can interfere with encoding, storage, and retrieval processes, all of which contribute to low performance. Zhang (2001) found that language anxiety, when experienced by language learners, can be damaging to the learning process, which is consistent with the finding that language anxiety directly undermines motivation and brings about a negative influence on the foreign language under study (Gardner et al., 1987) and that high anxiety interferes with thinking processes and cognitive behaviors, making learning less effective (MacIntyre & Gardner, 1994). The majority of recent studies also illustrate researchers' revived interest in this field. Garcia-Pastor & Miller (2019) discussed the needs of learners who stutter in EFL learning in relation to their levels of anxiety. The anxiety of the learners was measured using the FLCAS and the Specific Language Skill Anxiety Scale (SLSAS). They found anxiety as a hindrance in students' learning EFL language skills. Wang and Cha (2019) investigated 78 English majors from a Chinese university and examined the differences between, and the effects of FLLA factors on, listening performance in low and high-proficient EFL listeners. The results showed that the listening-anxiety factor was a predictor of poor performance in listening comprehension. Therefore, EFL listening comprehension anxiety becomes an issue which needs to be addressed in the classroom (Vogely, 1998). Listening anxiety occurs when students feel they are faced with a task that is too difficult or unfamiliar to them (Scarcella & Oxford, 1992). A recent study by Borekci & Yavuz (2017) has confirmed again such a finding, when the

two researchers explored foreign language listening anxiety among Turkish EFL learners.

Regarding the sources of EFL listening anxiety, only a few relevant studies on foreign language listening anxiety are reported in the literature. Vogely (1998) found that learners must be able to actively and strategically participate in the listening process within a low-anxiety classroom environment. He found that the sources of listening comprehension anxiety reported by the students are associated with four main factors: 1) characteristics of input, such as nature of the speech, level of difficulty, lack of clarity, lack of visual support, and lack of repetition; 2) process-related aspects of listening comprehension, such as inappropriate strategies, lack of processing time, cannot study listening comprehension, and cannot check answers; 3) instructional factors, such as lack of listening comprehension practice, the test thing, uncomfortable environment; and 4) personal attributes of teacher and learner, such as fear of failure/nervousness, and instructor's personality. Students also provided correspondent suggestions. Kim (2002) measured the listening anxiety of 253 EFL learners with the Foreign Language Listening Anxiety Scale (FLLAS) and the FLCAS, and examined the relationship between listening anxiety and learner background factors. The results indicted that EFL learners do experience anxiety in response to listening comprehension and that the two main factors leading to their anxiety are tension and worry over English listening and lack of self-confidence in listening. Hang (2006) conducted a similar study on listening comprehension anxiety based on students reporting sources and presented five categories of sources of listening anxiety, namely, characteristics of listening comprehension, characteristics of the listening materials, characteristics of the tasks, social sources of listening anxiety, and foreign language proficiency and listening level. In Chang's (2008) study of college students' EFL listening anxiety in a classroom context in Taiwan, participants showed moderately high intensity of anxiety in listening to spoken English. The three major sources of listening anxiety included: 1) low confidence in comprehending spoken English, 2) having to take English listening courses as a requirement, and 3) worrying about test difficulty.

2.2 Teacher Cognition

Within the field of teacher education, teacher cognition is used as a broad term which encompasses *teachers' knowledge*, *beliefs*, and *self-perceptions*. Defined as "the unobservable cognitive dimension of teaching – what teachers know, believe and think" (Borg, 2003: 81), teacher cognition has been shown to exert great influence on teachers' teaching practice (Barnard & Burns, 2012; Meijer et al., 1999).

Regarding how to perceive and understand teachers' classroom performance as well as why and how they make their instructional decisions actively, there emerges a growing body of research on teacher cognition, namely, teachers' beliefs, knowledge, theories, assumptions, and attitudes towards every aspect in their work (e.g., Basturkmen, 2012; Borg, 2003; Borg, 2011; Borg & Al-Busaidi, 2012; Ellis, 2019). This research has been expanding greatly within a wide range of language teacher

education settings: In both preservice and inservice contexts, at various levels (from kindergarten to adult education), and regarding many subjects (e.g., English and mathematics) and specific aspects of subjects (e.g., vocabulary, grammar, writing, reading, etc. in English learning).

Abundant literature on second language (L2) teacher cognition covers different curricular areas, such as the teaching of L2 grammar, L2 writing, L2 reading, L2 speaking, L2 vocabulary, and L2 pronunciation. The most recent teacher cognition studies include the teaching of L2 grammar (Sata & Oyanedel, 2019), writing (Ngo, 2018), speaking (Webster, 2019), and pronunciation (Couper, 2019). Although in recent years the research on L2 teacher cognition has expanded rapidly, there is paucity of research on teacher cognition in the field of L2 listening except for a few studies. For example, Gao & Liu (2013) investigated Chinese college English teachers' beliefs about listening instruction and the relationship between teacher beliefs and practices through a questionnaire survey of 325 teachers and a case study of four teachers. Their findings showed that although Chinese college English teachers under investigation have good understanding of the importance of teaching listening and the right focuses on the listening materials such as the background knowledge and local details, mismatches occur between their beliefs and teaching practices. Graham et al. (2014) looked into teachers' stated beliefs and stated practices of 115 foreign language teachers in England regarding listening pedagogy through a questionnaire, lesson observation, post-lesson teacher interviews, and textbook analysis to examine whether such beliefs and practices supported the literature on listening, whether the stated beliefs and stated practices converged, and what factors underpinned them. The results of the study showed that: 1) It is noticeable in teachers' comments that teachers tend to lay more emphasis on completing the task than on instructions of effective listening (p. 49); 2) in their instructional practices, teachers tend to advise students on the best way to listen but not put them into practice in their actual classroom teaching; 3) the task demands were clarified through ensuring that students understood clearly the requirements of the task and how to carried them out; 4) teachers emphasized more the doing or completion of listening tasks; 5) effective listening was described as the listener's ability to identify concrete details and individual items of vocabulary; 6) general instead of personal details found little reflection in respondents' answers; 7) as for such pre-listening activities as prediction, most learners understood them to be revising key words in the listening materials; 8) there is a mismatch between teachers' stated practice and their actual instructions in that they ignored the use of metacognitive strategies, students' exploration of knowledge by themselves, and post-listening activities like discussion. Karimi & Nazari's (2017) study on Iranian EFL teachers' beliefs about listening and their beliefs-driven instructional practices in teaching listening comprehension through a questionnaire and classroom observation showed variations in teachers' beliefs-practices. The results of their study indicated that there was no significant relationship between teachers' beliefs about listening instruction and their listening instructional practices, and that time was the

major obstacle for teachers to actualize their listening beliefs. Given the research gap briefly highlighted above, this study was set up to answer the following research questions.

1) Do teachers recognize the effect of anxiety on EFL listening in classroom teaching?
2) What is the teacher cognition about sources of EFL listening anxiety?

3. Methodology

3.1 Research Design

This study has adopted a qualitative approach to data collection and analysis. Qualitative research is not easy to define due to its "multifaceted nature" (Hitchcock & Hughes, 1995: 26). Yilmaz (2013: 312) synthesized previous studies on the definition of qualitative research and provided a comprehensive definition in which qualitative research is described as "an emergent, inductive, interpretative and naturalistic approach to the study of people, cases, phenomena, social situations and processes in their natural setting in order to reveal in descriptive terms the meanings that people attach to their experiences of the world." In terms of data collection, qualitative research is more concerned with the process, context, interpretation, and understanding via inductive reasoning (Koro-Ljungberg et al., 2017). Observations, interviews, and document analysis are the major methods that have been used to this end. In analyzing and interpreting data, qualitative researchers identify patterns, themes or categories in the data by organizing them into a more abstract form of information (Peters & Tesar, 2017).

The case study was adopted as the best option in this study for investigating teacher cognition about students' foreign language listening anxiety, because it is a method that allowed the researchers to obtain deeper insights into the phenomenon under study. It is concerned with a holistic context instead of a specific variable, with a process instead of a product, and with explanatory or exploratory findings instead of confirmatory studies with any pre-assumed hypothesis (Yin, 1994).

3.2 Sampling and Participants

Sampling in qualitative research can be best achieved by purposive sampling to identify participants who can offer varied and rich understanding of a case. Taking into consideration the issues of feasibility, iteration, and saturation, this study, through purposive sampling, selected five Chinese EFL listening teachers from a major university in northern China based on their differences in many aspects, such as age, gender, educational background, teaching years and teaching experiences. All of these factors were understood to have an impact on their cognitions. Apart from the principle of voluntariness, the participating teachers were chosen according to the following criteria as displayed in Table 3.1.

Table 3.1 Sampling Criteria

Criteria	Reason(s)
They must have been teaching EFL listening to English majors for at least one semester.	They can systematically arrange and share their cognitions about their classroom pedagogical instructions with the first author.
They represent a range of EFL listening teachers' characteristics.	They are teachers of different ages, different educational backgrounds, different work experiences, and different teaching styles.

In order to protect the participants from being negatively affected in any sense, a pseudonym was chosen for each of them. The demographic information about the five participating teachers is summarized in Table 3.2.

Table 3.2 Participating teachers' demographic information

Name	Amy	Daisy	Ella	Hannah	Alfred
Age	44	44	37	38	39
Gender	Female	Female	Female	Female	Male
Qualifications	BA	MA	MA	MA	MA
Years of teaching EFL	20+	20+	13	14	15
Years of teaching EFL listening	20+	0.5	7	1	15

3.3 Data Collection

Data were collected in the Semester One that ran from September 2015 to January 2016. Data collection consisted of two major phases. In Phase One (the first week of the semester), the first author conducted semi-structured in-depth interviews with the five university EFL listening teachers, which provided a holistic view on the participating teachers' cognitions about the sources of EFL listening anxiety. In Phase Two (the 2^{nd}–16^{th} week of the semester), classroom observations and post-observation interviews were held in an integrated way. The purpose of Phase Two was to observe and record the teachers' teaching behavior in teaching EFL listening and probe further into their mental lives that might shape their pedagogical decision-making when EFL listening anxiety occurred among students. Post-observation interviews sought explanations from the participating teachers about their classroom instructions.

The data in this research were collected through two main instruments: Interviews and observation. The interviews included pre-observation interviews and post-observation interviews. The pre-observation interviews were in-depth, semi-structured qualitative interviews which took approximately one hour for each participating teacher. The post-observation interviews were the stimulated recall interviews about the teachers' account of their instructional practices in the classroom. The observation of teachers' EFL listening instructional practices happened during the teaching process in the classroom, audio-recorded for later data transcription and analysis.

3.4 Data Analysis

All the data were transcribed verbatim. They were then analyzed under a framework guided by three stages of data processing: Data condensation, data display, and conclusion drawing/verification (Miles et al., 2014). The condensation of data in the present qualitative study, through the integration of the main methods and stages of qualitative data analysis elaborated in the literature (Braun & Clarke, 2006; Creswell, 2014; Strauss, 1987), was conducted by the first author in three steps: Transcription, coding, and analysis. These steps were closely interrelated and they paved the way for each other, making it possible for the analysis to move cyclically among these steps.

One key issue in transcribing the data, which is worth mentioning, was the translation of the transcripts. As "language differences may have consequences, because concepts in one language may be understood differently in another language" (Van Nes et al., 2010: 313), what to translate and when to translate was a difficult choice. Translation was not done during transcribing the interview data because the original language used by the participating teachers could better convey their meanings and be understood by the first author for comprehension and analysis. This decision is well justified in Sechrest et al.'s (1972) statement that much information can be lost in the course of translation because of the lack of equivalent vocabulary, syntax, idioms, and concepts between the source language and the target language.

Based on Braun & Clarke's (2006) six phases of thematic analysis, the first author developed a six-step data analysis model. The six-step model includes getting familiar with the data, writing summaries within cases, constantly comparing and contrasting across cases, generating initial codes, searching, reviewing, and naming themes, and producing the report. In order to confirm the validity of themes and categories, two PhD candidates working on relevant research topics in The University of Auckland were invited to analyze a small part of the data. These themes and categories were reviewed and verified by the two co-authors of this paper.

4. Teacher Cognition about Sources of EFL Listening Anxiety

The findings of this study indicate that the teachers agree that the difficulty students experience in EFL listening comprehension results in anxiety, and EFL listening anxiety is regarded as a primary reason that prevents students from reaching the expected performance level in learning EFL listening typically measured through tests in the classroom. The categories of sources of listening comprehension anxiety developed by Vogely (1998) were adopted to analyze teacher cognition about sources of EFL listening anxiety, which is shown in Table 4.1.

Table 4.1 Teacher cognition about the sources of EFL listening anxiety

Category	Sources of anxiety	Participant
Input	Unfamiliar cultural background	Amy, Ella, Hannah, Alfred
	Unfamiliar topic	Amy, Daisy, Ella, Hannah, Alfred
	Syntax	Amy, Daisy, Ella, Hannah, Alfred
	Vocabulary	Amy, Daisy, Ella, Hannah, Alfred
	Lack of visualizing ability	Alfred
	Genre	Hannah
	Fast speech rate	Amy, Daisy, Hannah, Ella
Process	Lack of EFL listening strategies	Daisy, Ella, Alfred
	Failure to check answers	Daisy
	Poor short-term memory	Daisy
Instructional factors	Lack of EFL listening practice	Alfred
	Uncomfortable EFL listening environment	Daisy, Ella
	Task types	Hannah
Personal factors	Nervousness of students when doing EFL listening	Amy
	Students' incorrect pronunciation	Amy, Daisy, Ella, Hannah, Alfred
	Instructor's teaching styles	Amy, Daisy

The 16 sources of EFL listening anxiety in the four categories of input, process, instructional factors, and personal factors reported by the participating teachers are elaborated on in the following sections.

4.1 Sources of EFL Listening Anxiety Related to Input Features

The category of input features takes a primary part in the sources of EFL listening anxiety reported by the participating teachers. The sources of EFL listening anxiety in this category can be further sorted into three main subcategories: Background information about the foreign language culture and the topic of the listening activity, linguistic factors, including syntax and vocabulary, and the speech rate of the recordings.

The participating teachers agreed that unfamiliarity with background information about the culture and topic involved in the EFL listening material caused EFL listening anxiety. Amy's views are representative of the other participants.

The cultural background is the first thing to know about (for students). A piece of listening material will be beyond comprehension without knowing the cultural background. (Amy, female, 44, 20+ years' teaching experience in EFL listening)

Amy also provided an example which illustrates the importance of familiarity with background information on the topic.

The listening material will be too difficult if it is not familiar (to you), isn't it? … Let's say the material is about a western custom: If you know about this western custom, it will be easy for you to comprehend; if you know nothing about it, it will be too difficult for you. (Amy, female, 44, 20+ years' teaching experience in EFL listening)

Daisy's suggestion of the importance of topic familiarity was agreed with by other participating teachers:

Maybe students are not familiar with the topic of the listening material. It can be about something very technical, such as topics concerning biology or engineering that students of liberal arts haven't learnt, which results in the loss in students' listening efficiency. Contrary to an ancient Chinese idiom that goes "every subject has its own experts," everyone has blind spots in his or her learning. (Daisy, female, 44, 0.5 years' teaching experience in EFL listening)

The second subcategory of linguistic factors, which includes syntax and vocabulary, is an important source of EFL listening anxiety. Difficulty with syntax, especially long and complex sentences, was identified by all the participants as an important source of this anxiety type. When sentences are too long, students lose their focus on meaning, and as listening is a linear and transient process, they cannot go back and check the parts where their comprehension was hindered, if the listening task was a test. The complexity of English sentences also makes them difficult as they are very different in structure from Chinese ones, as Amy said in this interview extract:

English sentence structure is different from that of Chinese sentences. A very simple example is about the sequence of sentence constituents: English sentences put the important information first, while Chinese sentences have a lot of attributive modifiers at the front and put the most important information at the end. (Amy, female, 44, 20+ years' teaching experience in EFL listening)

As well as differences in the sequence of sentence constituents, English sentences are especially difficult with complex grammatical features such as parenthesis and ellipses. Compound sentences consisting of a main clause and subordinate clauses are also difficult for students during EFL listening.

The second linguistic factor that produces listening anxiety is vocabulary. Daisy thinks this is the most important factor which hinders students from in-depth EFL listening comprehension. Hannah also found that vocabulary is one of the biggest barriers to listening, and the weakest point of her students. They emphasized that vocabulary blocks students from efficient EFL listening comprehension in two ways: For those students who are beginners and do not have a strong command of vocabulary (as in Hannah's and Alfred's case), some everyday English words may prevent them from proper reception of information; for students who do have a large vocabulary, unfamiliar technical terms and slang can be a problem. Technical terms are included in the technical topics of the EFL listening materials. They

account for the difficulty of EFL listening materials on technical topics. Slang words are another aspect of vocabulary in the EFL listening course which causes students' comprehension problems.

Examples can be found in the participants' interview data:

As for students in Year One in our college, their command of vocabulary is small. They need more time to memorize or to get familiar with the words. In my class I find that their main difficulty in comprehending listening is their limited vocabulary. (Alfred, male, 39, 15 years' teaching experience in EFL listening)

Vocabulary is a factor. They (students) sometimes may get stuck in a key word which they don't understand, and the word appears many times: This definitely has a negative influence on their listening efficiency. (Amy, female, 44, 20+ years' teaching experience in EFL listening)

Another source of EFL listening anxiety in vocabulary is slangs. In slangs, every word is familiar (to students), and the sentence patterns involved are also simple. However, students just don't understand the meanings conveyed (in the slangs). The meaning of a slang is not the simple combination of the meanings of the words contained in the slang. (Ella, female, 37, 7 years' teaching experience in EFL listening)

The third subcategory within input sources of listening anxiety is the speech rate of the speakers in the recordings. Four out of five participants mentioned that the fast speech rate was frequently a factor which accounted for anxiety in EFL listening. When the speech rate is fast, the message delivery to the students becomes slower and less efficient.

Apart from the three main subcategories presented above, some other input-related factors, such as lack of visualizing ability and genre of the listening materials, were also mentioned in the interview data. In Alfred's opinion, the ability to visualize during listening is an indicator of a good listener.

There is a saying concerning EFL reading, "An efficient reader can visualize what he reads." I think it is also true of a good listener. An efficient listener can visualize what he or she is listening to. He or she also able to visualize what they have heard. (Alfred, male, 39, 15 years' teaching experience in EFL listening)

The genre of the listening materials can be a cause of EFL listening anxiety, especially news reports because of their fast speech rate, up-to-date content and structure peculiar to the genre germane to news reports. Some textbooks have included TV news reports as teaching materials to be used in the EFL listening classroom, but seldom have the textbook writers addressed the challenge that such materials pose to EFL learners. What is comforting is that Bell (2003) explored the criteria for selecting TV news, which should have pedagogical implications for the

selection of EFL listening materials, which can help learners alleviate their levels of anxiety.

4.2 Sources of EFL Listening Anxiety Related to Process Features

Participating teachers mentioned three subcategories of process-related sources of EFL listening anxiety: The lack of EFL listening strategies, failure to check answers, and poor short-term memory. The first subcategory is the lack of EFL listening strategies in students and of EFL listening anxiety:

There is a misunderstanding about EFL listening comprehension among students. They think that the comprehension of listening materials means understanding or translating every word of the materials. Actually it is not the case. They instead need strategies as important for EFL listening. For example, some students do not know how to take notes during the listening process; as a result, they lose much information, which prevent them from good understanding of the material. (Daisy, female, 44, 0.5 years' teaching experience in EFL listening)

Students instead should be focusing on the message conveyed in the listening material. A misunderstanding of the process of EFL listening raises anxiety levels in the listening activity, and frustrates students through their preoccupation that they may miss the key point, or find that the topic is not what they expect. As a result, students of EFL listening always feel uncertain about the sentences they are listening to, which lowers their confidence, and thus reduces the time to engage with the following sentences.

The second subcategory is failure to check answers during the listening process. Unlike EFL reading, during which students can confirm the information and message by re-reading when they feel uncertain about some part of the material, unidirectional EFL listening is a linear and transient process during which students can only move forward and may lose the sound information they had just heard. Failure to check answers increases EFL listening anxiety for students during their listening process. Alfred talked about this topic:

Students look like lost at the time during listening process when they try to confirm some information but cannot. Listening is a linear process and cannot be reversed; you cannot listen back to the point that confuses you as you can in reading. (Alfred, male, 39, 15 years' teaching experience in EFL listening)

The third subcategory is students' poor short-term memory. Short-term memory gets its name because the knowledge that gets attention and moves on for further processing will be maintained in human mind for no more than 20 seconds (Karpov, 2014). The main function for short-term memory is not to store or maintain knowledge but to process it in depth (to think it over and over again). The processing of knowledge in short-term memory will determine if certain knowledge is to be

remembered, or not, and the way in which the knowledge is to be remembered. Daisy mentioned the effect of short-term memory on listening outcomes:

Short-term memory is important. As short-term memory affects reading, it also affects listening. A student will definitely have high listening scores if he or she has good short-term memory. (Daisy, female, 44, 0.5 years' teaching experience in EFL listening)

4.3 Sources of EFL Listening Anxiety Related to Instructional Factors

Three subcategories mentioned by the participating teachers fall into sources of EFL listening anxiety related to instructional factors: The lack of listening practice, uncomfortable environment, and task types. The first is the lack of listening practice. Alfred and Hannah emphasized this factor in their talk:

I think the primary reason for students' anxiety in EFL listening is the lack of listening practice. The amount of input is important. (Alfred, male, 39, 15 years' teaching experience in EFL listening)

Without a large amount of time immersed in EFL listening practice, I think it is super unrealistic for students to achieve anything in this course. (Hannah, female, 38, 1 year's teaching experience in EFL listening)

Alfred further explained that the insufficient class hours is a contributing factor to this source.

Limited help is offered through the EFL listening lessons to the improvement of students' listening ability due to the insufficient class hours. Let's say there are 48 or 64 periods of EFL listening in one semester, which occupies only a small portion of all the class hours in the whole semester. Even if you use every class hour 100% efficiently, the overall time (spent on EFL listening practice) cannot reach the ideal level. (Alfred, male, 39, 15 years' teaching experience in EFL listening)

The second subcategory is an uncomfortable or distracting environment for listening. Anything that happens in or outside the classroom, may distract students, or make them feel uncomfortable, thus negatively influencing their EFL listening performance. Daisy's view was consistent with other participants:

The environment of EFL listening, such as the noise outside the classroom, influences students' performance in listening practice. Therefore if there is noise outside the classroom in my class, I will have the door and windows closed to prevent those noises from distracting students away from attentive listening. (Daisy, female, 44, 0.5 years' teaching experience in EFL listening)

The third subcategory is task types. Some studies have found that task types have an influence on EFL listening performance (e.g., Brindley & Slatyer, 2002; Chang

& Read, 2006; Hu, 2006; Huang, 1998). According to the teachers, the task types mainly adopted in EFL listening classes include dictation, multiple choices, gap-fillings, and answering open-ended questions. The difficulty level of EFL listening practice related to task types is not fixed, but is subject to individual students' listening experience and their strength and weakness in listening. Although there are individual differences in students, it is generally accepted that, in terms of the requirements of task types and the information provided, the hierarchy of tasks from easy to difficult is multiple choice, gap-filling, dictation, and answering questions.

Teachers' remarks on task types as a source of students' anxiety in EFL listening were consistent with Lund's (1990) findings. Lund (1990) established a taxonomy for teaching second language listening tasks, in which he classified listening tasks into two main categories: Listener function and listener response. In his taxonomy, listener function has six subcategories: Identification, orientation, main idea comprehension, detail comprehension, full comprehension, and replication; while listener response contains nine subcategories: Doing, choosing, transferring, answering, condensing, extending, duplicating, modeling, and conversing. The classification of the four common task types in EFL listening, according to Lund's framework of listener function and listener response, are illustrated in Table 5.4 below. For conciseness the following abbreviation are used: MC – multiple choices; GF – gap-filling; DT – dictation; and AQ – answering open-ended questions.

Table 5.4 Classification of EFL listening task types in terms of listener function and listener response

Function Response	Identi-fication	Orien-tation	Main idea compre-hension	Detail compre-hension	Full compre-hension	Repli-cation
Doing						
Choosing		MC	MC	MC	MC	
Transferring	GF	MC; GF	MC	MC; GF	MC	
Answering		MC; AQ	MC; AQ	MC; AQ	MC; AQ	
Condensing	GF	GF; AQ	AQ	GF; AQ	AQ	
Extending		AQ	AQ	AQ	AQ	
Duplicating	GF; DT	GF		GF		DT
Modeling						
Conversing		MC; AQ	MC; AQ	MC; AQ	MC; AQ	

In multiple choice tasks, which is a traditional type of EFL listening tasks, students are asked to choose one answer from four options provided below the question. It is the easiest type of EFL listening task in form because it provides all the information needed to answer the question; what students need to do is to tell the correct one from the four options. In this task type, the listener functions involved are orientation, main idea comprehension, detail comprehension, and full comprehension; the listener responses involved are choosing, transferring, and answering.

Gap-filling ranks as the second easiest on the list because information, which assists students with listening comprehension process and working out the answers, is provided in the question. In this task type, the listener functions involved are identification, orientation, and detail comprehension; the listener responses involved are transferring, condensing and duplicating.

Dictation is difficult because no written information is provided and students need to replicate the original text accurately including every punctuation mark. In this task type, the listener functions involved are identification and replication; the listener response involved is duplicating.

The most difficult task type is answering questions in which no information is provided and students are asked to use their logical reasoning and language skills to answer the questions in organized sentences. Students need to first organize their thinking and then to organize their words, which involves a number of strategies and skills. In this task type, the listener functions involved are orientation, main idea comprehension, comprehension of details, and full comprehension; the listener responses involved are answering, condensing, extending, and conversing.

4.4 Sources of EFL Listening Anxiety Related to Personal Factors

Three subcategories under the source of difficulty related to personal factors are nervousness of students when doing EFL listening, students' incorrect pronunciation, and instructors' teaching styles. Among the three subcategories, students' incorrect pronunciation was highlighted by teachers.

Some students incorrectly pronounce certain words and regard the wrong pronunciation as correct, which results in their poor EFL listening ability. (Ella, female, 37, 7 years' teaching experience in EFL listening)

When elaborating on the subcategory of instructors' teaching styles, Alfred emphasized that teachers' harsh remark and correction of students' mistakes may raise students' EFL listening anxiety levels. He commented on this negative effect by verbalizing:

Students are afraid of making mistakes during EFL listening class especially when they are called to provide their answers. They tend to feel hurt or at least uncomfortable as a result of losing face in front of the whole class when they are criticized or discouraged by the teacher. (Alfred, male, 39, 15 years' teaching experience in EFL listening)

The sources of EFL listening anxiety related to personal factors are principally connected with pronunciation and students' fright of losing face in front of the whole class. As the students are not native speakers of English, they are not confident of their pronunciation even when they get the correct answer. Therefore they are often apt to hide themselves when the teacher calls their names.

5. Discussion and Interpretation

In view of the research questions stated above, teachers have identifiable cognitions about the sources of EFL listening anxiety. The interview data showed that they realized that EFL listening is not an easy task for students due to its complex nature which involves much more than passively absorbing information. Instead, EFL listening is an active and dynamic process between the listening material and the listener. This is consistent with Purdy's (1997: 7) definition of listening as an "active and dynamic process of attending, perceiving, interpreting, remembering, and responding to the expressed needs, concerns, and information offered by other human beings" and other definitions of listening (e.g., Mendelsohn & Lynch, 2013; Rost, 2011; Underwood, 1989).

Teachers recognized the negative effect of anxiety on EFL listening during classroom teaching, which is in keeping with the findings of most of the foreign language anxiety literature and studies on anxiety in the different language skills such as listening (Zhang, 2013). The anxiety in EFL listening is a result of listening to spoken materials without the possibility of reacting or interacting with the speaker, as pointed out in Graham et al.'s (2014) study.

Concerning our second research question, the interview and observation data in this study suggest that the participating teachers were aware of the sources of EFL listening anxiety. The sources mentioned by the teachers were diverse. Teachers emphasized background information about cultures and topics, linguistic factors such as vocabulary, and the speech rate of the speakers in the recordings as major sources of EFL listening anxiety related to input features. This finding aligns with those reported in Hang (2006), who found that characteristics of listening materials, especially the topic of the material and the difficulty of vocabulary, is a major source of listening anxiety. Vogely's (1998) research had similar findings about listening comprehension anxiety, which was termed "nature of the speech" as one input-related source of listening anxiety.

Lack of practice, lack of listening strategies, and failure to check answers were mentioned by participating teachers as major sources of EFL listening anxiety (see Vogely, 1998). Instructors' teaching styles mentioned by the participating teachers as a source of anxiety echo Hang's (2006) research as well, where "inappropriate teacher behavior in class" was found to be a social source of listening anxiety. Young's (1991) finding also points to the phenomenon that teachers' harsh manner of correcting students' errors is often anxiety-provoking. The participating teachers mentioned genre and task types as sources of EFL listening anxiety. Similar results were found in Chang's (2008) study on sources of EFL listening anxiety. Scarcella & Oxford (1992) also found that students have listening anxiety when they feel they are faced with a too difficult or unfamiliar task. Teachers' cognitions about students' incorrect pronunciation, and the linguistic factor of syntax, namely, long and difficult sentences, as sources of EFL listening anxiety finds little correspondence in the relevant literature. This is really some interestingly meaningful

finding that adds new empirical evidence to the research on the sources of EFL listening anxiety.

6. Conclusions

This qualitative study was set up to investigate teachers' cognitions about the sources of EFL listening anxiety. It was found that 16 sources organized into four categories contributed to their EFL listening anxiety, among which students' unfamiliarity with cultural backgrounds and topics in the category of input played a prominent role. Such research on teacher cognition about the sources of EFL listening anxiety and the findings have theoretical implications for research on EFL listening anxiety and on teacher cognition. It modestly expands the knowledge about EFL listening anxiety by focusing on what teachers think and believe, instead of what only focusing on what students think. More meaningfully, the study was carried out qualitatively in order to counterbalance the dominant trend in foreign language anxiety research that is predominantly quantitative in methodology. This study also provides new empirical evidence for the research on teacher cognition about EFL listening anxiety because the findings related to teachers' cognitions about students' incorrect pronunciation, and the linguistic factors of syntax as sources of EFL listening anxiety are new to the field of teacher cognition research. The findings from the present research might also have pedagogical implications for teachers of EFL listening. Being aware of the sources of EFL listening anxiety appears to be a necessary first step before teachers adapt their teaching of EFL listening in various stages to alleviate students' anxiety and facilitate their students' learning outcomes, typically shown in their students' development of language proficiency.

Despite its significance, our study is not exempt from limitations. A two-stage qualitative research design was adopted to explore five teachers' cognitions about the sources of EFL listening anxiety over a 16-week academic semester. Although the study was well-planned and carefully carried out, two limitations need to be taken into consideration: The small sample size and the lack of data from students. Firstly, whereas a sample of five teachers from one Chinese university is appropriate for qualitative research, a larger sample size from different universities or provinces would ensure greater representativeness and generalizability of the results. Secondly, data from students' perspectives, such as their classroom learning of EFL listening and their cognitions about the sources of EFL listening anxiety as complementary evidence, may have allowed for a more holistic study.

Future research might consider increasing the number of the participants and broadening the contexts from which they were chosen for greater generalization. The possible differences among teachers in aspects such as birthplaces, educational backgrounds, working experiences, and professional development can lead to differences in their cognitions about EFL listening anxiety. Secondly, it is advisable for future research to include data on students' classroom learning and their cognitions about the sources of EFL listening anxiety to be collected through interviews and/or

other data collection instruments (e.g., the Foreign Language Listening Anxiety Scale, Kim, 2002). The evidence from students' perspective would provide feedback to teachers and enhance their cognitions about EFL listening, especially listening anxiety.

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Author Contributions
All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of Interest Statement
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Deep Learning Algorithms and Big Health Care Data in Clinical Natural Language Processing

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ABSTRACT. Empirical evidence on big health care data in clinical natural language processing has been scarcely documented in the literature. Using and replicating data from 3M Health Information Systems, Amazon, GE Healthcare, Maruti Techlabs, McKinsey, Mindfields, MIT Technology Review Insights, and TDWI, I performed analyses and made estimates regarding high-potential natural language processing (NLP) use cases in healthcare (%, relevance). Data were analyzed using structural equation modeling.

Keywords: deep learning algorithm; big data; healthcare; clinical natural language processing

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1. Introduction

Adverse events in healthcare are routinely organized in incident reports which comprise unstructured free text, and acquiring knowledge from such issues may enhance patient safety. Natural language processing (NLP) harnesses computational methods to examine free text, diminishing the human workload related to its interpretation. (Young et al., 2019) NLP-based models can adjust to health care management, thus possibly optimizing decision making, cutting down expenses, and expand access to care. (Brown and Kachura, 2019)

2. Conceptual Framework and Literature Review

Reproducibility of NLP approaches and differentiation among outcomes (Atwell and Lăzăroiu, 2019; Eskridge, 2019; Kenrick et al., 2019; Majerova et al., 2020; Rădulescu, 2019; Szewieczek, 2019) constitutes the mainstay of biomedical NLP

analysis, but patient data encompassing clinical textual notes should be made distributable. (Weng et al., 2019) NLP can be employed to determine symptoms from narrative clinical documentation. (Chan et al., 2020) NLP and text mining are instrumental in the interpretation of sub-clinical symptoms and enhanced self-government. (Dreisbach et al., 2019) The processing in advance of clinical documents by NLP can thoroughly shape the improvement process of the clinical decision support system. (Becker et al., 2019) Clinical NLP systems swiftly evaluate patients' admissibility derived from their longitudinal medical records. (Chen et al., 2019a) Rule-based systems, and especially those harnessing regular expressions, are on many occasions quite helpful in handling medical NLP issues. (Sharma et al., 2019) NLP can derive social isolation data from clinical notes with significant accuracy and recall. (Zhu et al., 2019)

3. Methodology and Empirical Analysis

Using and replicating data from 3M Health Information Systems, Amazon, GE Healthcare, Maruti Techlabs, McKinsey, Mindfields, MIT Technology Review Insights, and TDWI, I performed analyses and made estimates regarding high-potential NLP use cases in healthcare (%, relevance). Data were analyzed using structural equation modeling.

4. Results and Discussion

The pervasive acceptance of electronic health records has generated large volumes of digital text as regards patients, while the medical informatics community employs clinical text significantly through NLP. (Wu et al., 2020a) The extremely structured character of medical reports makes them viable for computerized wide-reaching patient identification. (Wu et al., 2020b) Data from the clinical notes of the electronic health record of trauma patients are feasible for phenotyping operations with supervised machine learning and NLP. (Afshar et al., 2019) The adoption of machine learning in health care delivery necessitates information processed in advance, model training, and improvement of the system (Bratu, 2018; Groener, 2019; Nica, 2015; Roth, 2019; Vochozka et al., 2018) concerning the actual clinical issues. (Ngiam and Khor, 2019) (Tables 1–9)

Table 1 Has your health care institution adopted or is considering artificial intelligence? (%)

No plans	6
Considering deploying artificial intelligence in the next two years	27
Considering deploying artificial intelligence in the next 12 months	14
In the process of obtaining artificial intelligence	16
Have deployed one artificial intelligence pilot project or more	17
Have deployed one artificial intelligence application or more	20

Sources: MIT Technology Review Insights; GE Healthcare; my survey among 3,800 individuals conducted November 2019.

Table 2 Benefits/drivers for machine learning, NLP, or artificial intelligence (%, relevance)

Understand behaviors	72
Improve business performance	67
More accurate business insights	64
Competitive differentiator	59
Better customer experience	55
Operational efficiency	52
Improve productivity	49
Faster response	47
Monetize data	45

Sources: TDWI; my survey among 3,800 individuals conducted November 2019.

Table 3 High-potential NLP use cases in healthcare (%, relevance)

Administrative cost reduction	89
Efficient billing: Extract relevant information from unstructured physician notes and appropriately assign medical codes to facilitate the billing process	84
Accurate prior authorization approval: Leverage information from physician notes to alleviate delays and administrative errors	80
Medical value creation	82
Effective clinical decision support: Aid members and healthcare providers with decision support at the point of need	86
Streamlined medical policy assessment: Compile and compare clinical guidance from public sources to define the most appropriate care guidelines for care delivery	84

Sources: McKinsey; my survey among 3,800 individuals conducted November 2019.

Table 4 How Amazon Comprehend Medical works (%, relevance)

Automatically extracts medications, medical conditions, test, treatment and procedures (TTP), anatomy, and protected health information (PHI).	89
Provide unstructured medical text from a variety of sources, e.g., doctors' notes, clinical trial reports, and patient health records.	92
Identifies relationships among the extracted medication, test, treatment, and procedure information. The service identifies traits like negation, diagnosis, and symptoms for medications and medical conditions.	91

Sources: Amazon; my survey among 3,800 individuals conducted November 2019.

Table 5 Applications of NLP in healthcare (%, relevance)

NLP tools might be able to bridge the gap between the insurmountable volume of data in healthcare generated every day and the limited cognitive capacity of the human brain.	93
The key to the success of NLP in healthcare will be to develop algorithms that are accurate, intelligent, and healthcare-specific while creating user interfaces that can showcase decision support data in the desired format.	91
NLP in the healthcare industry can help enhance the accuracy and completeness of electronic health records by transforming the free text into standardized data, making also documentation easier by allowing care providers to dictate notes as NLP turns it into documented data.	88

Sources: Maruti Techlabs; my survey among 3,800 individuals conducted November 2019.

Table 6 Categories of NLP that cover many of the most common applications (%, relevance)

Machine translation	Translation services translate the contents of foreign language web pages.	84
Speech recognition	Familiar to the healthcare industry for its use in automated transcription and dictation software, it processes plain speech input and is widely used to service clients on telephone voice response systems.	78
Question answering	It works with plain speech input and uses it as the basis for an information search, extracting relevant information from the text, querying multiple evidence sources, and integrating the results to identify the most confident response.	76
Knowledge extraction	It must understand and interpret input in order to produce valid information as its output.	79
Classification	It neatly sorts and organizes information for us into relevant categories.	82

Sources: 3M Health Information Systems; my survey among 3,800 individuals conducted November 2019.

Table 7 Driving factors behind NLP in healthcare (%, relevance)

Handle the surge in clinical data	84
Support value-based care and prognostics and health management applications	82
Improve patient–provider interactions with electronic health records	78
Empower patients with health literacy	77
Address the need for higher quality of healthcare	75
Identify patients who need improved care	72

Sources: Maruti Techlabs; my survey among 3,800 individuals conducted November 2019.

Table 8 NLP in healthcare (associated use cases – %, relevance)

Mainstay use cases of NLP in healthcare that have a proven return on investment	
Speech recognition	72
Improvement in clinical documentation	79
Data mining research	87
Computer-assisted coding	86
Automated registry reporting	91
Emerging use cases of NLP in healthcare that will have an immediate impact	
Clinical trial matching	88
Prior authorization	80
Clinical decision support	87
Risk adjustment and hierarchical condition categories	83
Next-gen use cases of NLP in healthcare that are on the horizon	
Ambient virtual scribe	77
Computational phenotyping and biomarker discovery	82
Population health management and analysis	86

Sources: Maruti Techlabs; my survey among 3,800 individuals conducted November 2019.

Table 9 Barriers for artificial intelligence adoption in healthcare (%, relevance)

With the addition of new parameters in healthcare information such as images, audio and video, artificial intelligence is desired to have context specific capability for decision making.	84
Despite the growth in electronic data, many healthcare organizations still lack an integrated platform. This is a challenge when establishing the building blocks for artificial intelligence implementation.	81
One of the major roadblocks for artificial intelligence in healthcare is the low level of consistency among the records of healthcare providers resulting in inaccurate analysis of the captured data.	78
Limited availability of skilled employees in healthcare who can initiate artificial intelligence-based projects, is creating a hindrance for healthcare organizations.	74

Sources: Mindfields; my survey among 3,800 individuals conducted November 2019.

5. Conclusions and Implications

Clinical NLP methods can be commonly segmented into two kinds: rule-based systems and machine learning (that is, statistical) ones. Rule-based systems, for a long time established in the clinical setting, are determined by manual definition of procedures (that is, regular expressions) that detect phrases of interest in notes. Statistical approaches are based on the fashioning of a manually annotated data set to regulate a machine learning model that is subsequently employed to derive entities and notions from unannotated notes. (Chen et al., 2019b) Text mining represents the technology harnessed to categorize, cluster, infer, search, and inspect data (Durst, 2019; Hardingham et al., 2018; Lăzăroiu et al., 2020; Popescu Ljungholm, 2018; Slaby, 2019; Wingard, 2019) to identify patterns or characteristics in various unstructured or structured reports jotted in natural language. (Kim and Chung, 2019)

Note

The interviews were conducted online and data were weighted by five variables (age, race/ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

Author Contributions

The author confirms being the sole contributor of this work and approved it for publication.

Conflict of Interest Statement

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Machine Learning-based Natural Language Processing Algorithms and Electronic Health Records Data

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ABSTRACT. I develop a conceptual framework based on a systematic and comprehensive literature review on the relationship between machine learning-based natural language processing (NLP) algorithms and electronic health records data. Building my argument by drawing on data collected from 3M Health Information Systems, Maruti Techlabs, McKinsey, Mindfields, and TDWI, I performed analyses and made estimates regarding immediate benefits healthcare organizations can get by leveraging NLP (%, relevance). The data for this research were gathered via an online survey questionnaire and were analyzed through structural equation modeling on a sample of 4,200 respondents.

Keywords: electronic health record; machine learning; natural language processing

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1. Introduction

Natural language processing (NLP) can produce important input from unstructured data in the particular sphere of the categorization of incident reports and adverse events. (Young et al., 2019) Any addition of NLP methods necessitates infrastructure (Bolton et al., 2018; Byrne, 2019; Lăzăroiu et al., 2017; Lyakina et al., 2019; Nica, 2017; Popescu Ljungholm, 2018; Sheller, 2019) to examine the contents of electronic health record clinical notes. (Hazlehurst et al., 2019) Including NLP in the harnessing of administrative codes enables swift discerning of critically ill patients with otherwise challenging to determine disease operations and puts an end to expensive, annoying, and non-performing manual chart review. (Udelsman et al., 2019)

2. Conceptual Framework and Literature Review

Significant, multilevel, and homogenized data sets may decipher fresh insights and advancing breakthroughs (Bratu, 2018; Harrower, 2019; Lăzăroiu, 2018; Mitea, 2018; Rönnström and Roth, 2019; Sion, 2019), but only a small proportion of them are being systematized, assimilated, comprehended, and inspected. Artificial intelligence deals with how computers acquire knowledge from data and mirror human thought operations, furthering learning capacity and improving the decision support system massively (Bratu, 2019; Krizanova et al., 2019; Lăzăroiu et al., 2019; Popescu, 2014; Schinckus, 2018; Szewieczek, 2019), and thus reshaping the direction of health care. (Noorbakhsh-Sabet et al., 2019) NLP is employed to derive data from electronic health record free-text reports documented by diverse healthcare suppliers on a wide-ranging series of symptoms throughout a variety of clinical specialties. (Koleck et al., 2019) A cutting-edge rule-based clinical NLP system can attain satisfactory performance on cohort selection even using an insubstantial training data set. (Chen et al., 2019) NLP may be practical for the high-performing determining of patient-centered results when adopting electronic health records. (Chan et al., 2020) NLP software tools and processes make larger chart abstractions within the bounds of possibility and enable a more broad-ranging assessment of certification of lifestyle modification. (Shoenbill et al., 2019)

3. Methodology and Empirical Analysis

Building my argument by drawing on data collected from 3M Health Information Systems, Maruti Techlabs, McKinsey, Mindfields, and TDWI, I performed analyses and made estimates regarding immediate benefits healthcare organizations can get by leveraging NLP (%, relevance). The data for this research were gathered via an online survey questionnaire and were analyzed through structural equation modeling on a sample of 4,200 respondents.

4. Results and Discussion

Interpretation of big data by machine learning provides relevant upsides for incorporation and assessment of huge volumes of elaborate health care information. Strong points of harnessing machine learning tools/algorithms in health care comprise adjustability and scalability in contrast to established biostatistical approaches, in addition to their capacity to inspect various data types and assimilate them into forecasts for disease risk, diagnosis, prognosis, and prompt therapeutics. (Ngiam and Khor, 2019) NLP is a streamlined, rigorous method for wide-ranging retrospective patient identification. (Wu et al., 2020) Processing immense quantities of data demonstrates the advantages of NLP and machine learning in reorganizing a phenotyping undertaking from unstructured information (Afshar et al., 2019) (Tables 1–6)

Table 1 What immediate benefits can healthcare organizations get by leveraging NLP? (%, relevance)

Improve patient interactions with the provider and the electronic health record	NLP solutions can help bridge the gap between complex medical terms and patients' understanding of their health, can combat the electronic health record distress, and is an alternative method to typing and handwriting notes.	87
Increasing patient health awareness	Even when patients can access their health data through an electronic health record system, a majority of them have trouble comprehending the information. As only a fraction of patients are able to use their medical information to make health decisions, the application of machine learning in healthcare is instrumental.	84
Improve care quality	NLP tools can offer a better provision to evaluate and improve care quality, their algorithms assisting in identifying potential errors in care delivery.	82
Identify patients with critical care needs	NLP algorithms can extract vital information from large datasets and provide physicians with the right tools to treat patients with complex issues.	78

Sources: Maruti Techlabs; my survey among 4,200 individuals conducted December 2019.

Table 2 Examples of NLP approaches and applications (%, relevance)

Doc2Vec: Vector representations of clinical documents	Compare and detect changes in clinical guidelines and lab reports	82
Named entity recognition: Leveraging unified medical language system (UMLS)	Extract clinical concepts (e.g., diagnoses, procedures, and symptoms) from electronic medical records, patient discharge summaries, and lab reports	80
Sequence to sequence: Using stacks of long short-term memory (LSTM) networks	Map clinical concepts and diagnoses with codified clinical guidelines	78
Deep reinforcement learning and contextual bandits: Using deep Q-networks	Develop human-to-machine natural language instructions (e.g., robot-assisted surgery guided by human instructions, search-oriented conversations)	75

Sources: McKinsey; my survey among 4,200 individuals conducted December 2019.

Table 3 Reasons for artificial intelligence adoption in healthcare (%, relevance)

Increase in digital data and difficulties in handling large amount of patients' records is pushing end-users to adopt artificial intelligence.	84
Increase in number of diseases and need to understand and diagnose better with the help of deep learning.	82
Through content analytics using NLP tools, artificial intelligence can enable speedy diagnosis of patient's conditions, thereby supporting the provider in administering effective and efficient treatment protocols.	81
With the adoption of artificial intelligence, many healthcare organizations have experienced a reduction in the costs and improvement in efficiency by treating larger number of patients.	79

Sources: Mindfields; my survey among 4,200 individuals conducted December 2019.

Table 4 Most NLP systems include common steps such as the following (%, relevance):

Tokenization	It is usually rule-based and fairly straightforward. What are the words and punctuation signs that the system needs to pay attention to?	74
Sentence and structure detection	NLP in a computer-assisted coding application needs to identify the sections of the clinical narrative that represent the patient history, present diagnosis, etc. There are a myriad of things to detect, ranging from the paragraph breaks to the section headings of a radiology report. Special rules have to be identified.	72
Part-of-speech (POS) tagging	NLP must be able to understand and interpret the surrounding terms and understand the context in which certain words are used.	75
Normalization	There are many ways of looking up all the meanings for one term or considering all the different ways people can say the same thing. A comprehensive data dictionary should include all possible abbreviations, variants, alternative expressions, and even misspellings and slang terminology used to describe a single concept.	74
Named entity resolution	The NLP engine should look up all important words in a dictionary/ontology resource and resolve the meanings into a concrete concept.	76
Parsing	This step basically answers the question, "What is the structure of this sentence?"	72
Negation and ambiguity detection	How often do we encounter a phrase and wonder if it is negating an idea or introducing doubt and ambiguity?	73
Semantics	An NLP computer-assisted coding application must examine linguistic evidence and arrive at a final output in the form of a code, a classification, etc. And that output must make sense to the human being on the receiving end of the information.	76

Sources: 3M Health Information Systems; my survey among 4,200 individuals conducted December 2019.

Table 5 What machine learning techniques are you using? Please select all that apply. (%, relevance)

Decision trees	67
Statistical methods such as regression	62
Clustering	54
Neural networks	56
Naïve Bayes classification	44
Association rule learning	47
Deep learning	49
Dimensionality reduction algorithms	42
Boosting algorithms	39
Support vector machines	32

Sources: TDWI; my survey among 4,200 individuals conducted December 2019.

Table 6 Specific tasks for NLP systems (%, relevance)

Summarizing lengthy blocks of narrative text, such as a clinical note or academic journal article, by identifying key concepts or phrases present in the source material.	72
Mapping data elements present in unstructured text to structured fields in an electronic health record in order to improve clinical data integrity.	69
Converting data in the other direction from machine-readable formats into natural language for reporting and educational purposes.	67
Answering unique free-text queries that require the synthesis of multiple data sources.	65
Engaging in optical character recognition to turn images, like PDF documents or scans of care summaries and imaging reports, into text files that can then be parsed and analyzed.	67
Conducting speech recognition to allow users to dictate clinical notes or other information that can then be turned into text.	66

Sources: Maruti Techlabs; my survey among 4,200 individuals conducted December 2019.

5. Conclusions and Implications

NLP can be employed to derive admissibility criteria from electronic health record clinical notes and swiftly identify patients seemingly suitable for a clinical trial with satisfactory preciseness, which can be used to cut down the amount of work for medical staff screening patients for trials. (Meystre et al., 2019) Deep learning carries out fact-based image-derived tissue categorization and can produce virtual computed tomography images from magnetic resonance imaging data sets. NLP analyzes medical literature and proficiently refashions years of picture archiving and communication system and electronic medical record information. (Douglas Miller and Brown, 2019) A distributable archive of clinical notes that has breadth (from various organizations) and depth (large volumes of longitudinal data from persons) would facilitate rigorous testing of clinical NLP tools. (Weng et al., 2019)

Note

The interviews were conducted online and data were weighted by five variables (age, race/ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

Author Contributions

The author confirms being the sole contributor of this work and approved it for publication.

Conflict of Interest Statement

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Will Autonomous Flying Car Regulation Really Free Up Roads? Smart Sustainable Air Mobility, Societal Acceptance, and Public Safety Concerns

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ABSTRACT. Based on an in-depth survey of the literature, the purpose of the paper is to explore whether autonomous flying car regulation will really free up roads. Using and replicating data from ANSYS, Deloitte, Foresight Institute, and SWT, we performed analyses and made estimates regarding comfortability with flying taxis (%), the likely benefits of flying cars (%), reasons urged against the concept of flying cars (%), level of concern with the overall safety of flying cars and with learning to use a flying car (%), level of concern with the performance of flying cars in congested airspace, in poor weather, and at night (%), and level of importance of having a parachute for flying cars (%). Data were analyzed using structural equation modeling.

Keywords: flying car; regulation; urban air mobility; aerial transportation system; safety

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1. Introduction

When assessing the adoption of urban air mobility, grasping the potential consumers' choice behavior with reference to available urban transportation modes and self-driving ride services is pivotal to demand appraisal. (Fu et al., 2019) Safety, trust, predisposition to automation, data uncertainties, social feedback, the practicality of time savings, the perception of machine control expenses, and service consistency shape the implementation and use of urban air mobility. (Al Haddad et al., 2020)

2. Conceptual Framework and Literature Review

Urban air mobility may decrease travel time and alter ride patterns. (Fu et al., 2019) Air taxis represent cutting-edge aviation ridesharing services (Rajendran and Zack, 2019) and as viable urban vehicles may activate a mindset shift (Douglas, 2018; Ion-Ebrasu et al., 2020; Lăzăroiu et al., 2020; Nica, 2019) in the manner individuals and commodities circulate in metropolitan areas (Androniceanu and Tvaronavičienė, 2019; Flygare, 2019; Kohlhoffer-Mizser, 2019; Mihăilă, 2019; Trettin et al., 2019) crowded by car traffic. (McCausland, 2020) The impeding acceptance of flying cars in the traffic fleet will refashion the mobility practices of urban riders. (Eker et al., 2020) Personal aerial transportation systems may homogenize the upsides of ground- and air-based ride, cutting down urban jam by employing available space in the air. (Fleischer et al., 2019) The Internet of Things is being displayed throughout transportation (Atwell and Lăzăroiu, 2019; Groener, 2019; Lăzăroiu et al., 2017; Mircică, 2019; Tuyls and Pera, 2019), as flying cars necessitate a merging of technologies. (Bogers et al., 2019) As a result of the issues related to escalating road congestion, furthering more sustainable travel behavior is needed. (Guo and Peeta, 2020) Sharing data in a connected setting (Chuanyue, 2019; Ionescu, 2019; Lăzăroiu, 2018; Nica et al., 2019a, b; Westbrook et al., 2019) is instrumental in car users' operational and strategic regulation, enhancing driving task performance. (Sharma et al., 2020)

3. Methodology and Empirical Analysis

Using and replicating data from ANSYS, Deloitte, Foresight Institute, and SWT, we performed analyses and made estimates regarding comfortability with flying taxis (%), the likely benefits of flying cars (%), reasons urged against the concept of flying cars (%), level of concern with the overall safety of flying cars and with learning to use a flying car (%), level of concern with the performance of flying cars in congested airspace, in poor weather, and at night (%), and level of importance of having a parachute for flying cars (%). Data were analyzed using structural equation modeling.

4. Results and Discussion

The hybrid activity of flying cars on the ground and in the air, alongside their (semi-)automated performance, may give rise to more attractive trip specifics, e.g. travel time, fuel consumption, or green emissions, in addition to the materialization of further sources of discomforts for the potential users. (Eker et al., 2020) Self-driving and electrification are bounded by overcrowding on current arteries and land-use barriers, whereas electric vertical takeoff and landing aircraft can facilitate technologically advanced aerial travel services. (Kasliwal et al., 2019) Travel time and associated expenses together with safety are pivotal drivers in autonomous transportation mode implementation. (Fu et al., 2019) (Tables 1–13)

Table 1 Reasons urged against the concept of flying cars (%)

They are impractical	23
They would be noisy or unsightly	27
They would be dangerous, to the occupants or to people on the ground	34
The average person is not a good pilot	39
Kids would do irresponsible things with them	37
They wouldn't really be as comfortable, convenient, etc as predicted	21

Sources: Foresight Institute; our survey among 4,700 individuals conducted December 2019.

Table 2 Do you agree with the statement: "Fully autonomous aerial passenger vehicles will not be safe"? (%)

Strongly disagree	8
Somewhat disagree	19
Undecided	36
Somewhat agree	24
Strongly agree	13

Sources: Deloitte; our survey among 4,700 individuals conducted December 2019.

Table 3 Do you agree with the statement: "Fully autonomous aerial passenger vehicles would be a viable solution to roadway congestion"? (%)

Strongly disagree	7
Somewhat disagree	13
Undecided	25
Somewhat agree	36
Strongly agree	19

Sources: Deloitte; our survey among 4,700 individuals conducted December 2019.

Table 4 Would you ride in a flying taxi if it meant getting to your destination faster? (%)

Definitely	37
Probably	43
Probably not	12
Definitely not	8

Sources: ANSYS; our survey among 4,700 individuals conducted December 2019.

Table 5 What are your greatest concerns about riding in a flying taxi? (%)

Safe take-off	17
In-air issues: A pilot not being available to respond to external conditions	44
Technology failure – Something going wrong with the technology flying the taxi and there being no pilot to help.	68
Safe and comfortable landings	23

Sources: ANSYS; our survey among 4,700 individuals conducted December 2019.

Table 6 When do you anticipate that you'd feel ready and comfortable to ride in a flying taxi? (%)

Right now	14
Within the next year	18
Within the next five years	21
Within the next ten years	20
In more than ten years' time	13
I would never be comfortable with this	14

Sources: ANSYS; our survey among 4,700 individuals conducted December 2019.

Table 7 The likely benefits of flying cars (%)

Shorter travel time	92
Fewer crashes	67
Better fuel economy	72
Lower emissions	74

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

Table 8 Level of concern with the overall safety of flying cars (%)

Very concerned	52
Moderately concerned	27
Slightly concerned	14
Not at all concerned	7

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

Table 9 Level of concern with the performance of flying cars in congested airspace (%)

Very concerned	34
Moderately concerned	33
Slightly concerned	19
Not at all concerned	14

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

Table 10 Level of concern with the performance of flying cars in poor weather (%)

Very concerned	44
Moderately concerned	33
Slightly concerned	14
Not at all concerned	9

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

Table 11 Level of concern with the performance of flying cars at night (%)

Very concerned	22
Moderately concerned	42
Slightly concerned	21
Not at all concerned	15

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

Table 12 Level of concern with learning to use a flying car (%)

Very concerned	30
Moderately concerned	42
Slightly concerned	17
Not at all concerned	11

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

Table 13 Level of importance of having a parachute for flying cars (%)

Very concerned	39
Moderately concerned	42
Slightly concerned	12
Not at all concerned	7

Sources: SWT; our survey among 4,700 individuals conducted December 2019.

5. Conclusions and Implications

The imminent embracing of flying cars is directly related to citizens' perceptions of the upsides and apprehensions developing out of the use of such vehicles. (Eker et al., 2020) The potential users may be inclined to spend more for harnessing self-driving transportation modes, particularly the service of urban air mobility. (Fu et al., 2019) Individual-specific socio-demographic, behavioral, attitudinal, and driving traits shape the public perceptions with regard to the safety attributes of flying cars, in addition to the positions concerning likely security interventions. (Eker et al., 2019)

Survey method

The interviews were conducted online and data were weighted by five variables (age, race/ ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. Sampling errors and test of statistical significance take into account the effect of weighting. Stratified sampling methods were used and weights were trimmed not to exceed 3. Average margins of error, at the 95% confidence level, are +/-2%. For tabulation purposes, percentage points are rounded to the nearest whole number. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

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Author Contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Repeated COVID-19 Pandemic-related Media Consumption: Minimizing Sharing of Nonsensical Misinformation through Health Literacy and Critical Thinking

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ABSTRACT. The aim of this paper is to synthesize and analyze existing evidence on repeated COVID-19 pandemic-related media consumption. Using and replicating data from Annenberg Science Knowledge/the University of Pennsylvania and the University of Illinois at Urbana-Champaign, Gallup, GlobalWebIndex, Knight Foundation, Ofcom, Pew Research Center, Reuters Institute for the Study of Journalism, and the University of Canberra, we performed analyses and made estimates regarding attitudinal statements about COVID-19 and media coverage. Data were analyzed using structural equation modeling.

Keywords: COVID-19; media consumption; nonsensical misinformation; health literacy

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1. Introduction

The COVID-19 pandemic has frightening repercussions for emotional and social functioning (Androniceanu and Tvaronavičienė, 2019; Eysenck et al., 2019; Hollowell et al., 2019; Lyakina et al., 2019; Petreanu et al., 2020; Zhuravleva et al., 2019), as pandemic-related news can be emotionally disturbing. (Pfefferbaum and North, 2020) COVID-19 involves a significant degree of anticipatory anxiety: considering the time interval for the inevitable course and spread of such a deadly virus, viewers are likely to feel apprehensive preponderantly about the future. (Horesh and Brown, 2020) As negative emotions intensify, viewers may resort to negative information as regards COVID-19 to make decisions. (Bavel et al., 2020)

2. Conceptual Framework and Literature Review

News outlets and social media comprise the current terrifying narratives of rampant increases in COVID-19 patients, diminishing medical supplies, emotionally distressing decisions as a result of care rationing, and infected primary care providers. (Graham et al., 2020) Individuals' anxiety is driven to some extent by the abundance of information supplied by social media (Atwell et al., 2019; Gray-Hawkins et al., 2019; Lăzăroiu, 2017; Nica, 2017; Roth, 2019), and unpredictability about reality (Atwell and Lăzăroiu, 2019; Fuentes, 2019; Kenrick et al., 2019; Mircică, 2019; Popescu, 2017) is adversely affecting their mental state. (Wiederhold, 2020a) Misinformation may bring about a deceiving sense of comfort. (Mesa Vieira et al., 2020) Social media can educate viewers and counteract fake news. (Mussetti et al., 2020)

3. Methodology and Empirical Analysis

Using and replicating data from Annenberg Science Knowledge/the University of Pennsylvania and the University of Illinois at Urbana-Champaign, Gallup, GlobalWebIndex, Knight Foundation, Ofcom, Pew Research Center, Reuters Institute for the Study of Journalism, and the University of Canberra, we performed analyses and made estimates regarding attitudinal statements about COVID-19 and media coverage. Data were analyzed using structural equation modeling.

4. Results and Discussion

COVID-19-related information may result in significant degrees of anxiety among the viewers. (Guitton, 2020) Ubiquitous, heightened, and perpetual media exposure to the COVID-19 crisis may influence viewers to inadequately anticipate the seriousness to their families and friends, generating amplified anxiety, intense stress reactions that may generate long-term consequences on health, and disorganized health-protective and help-seeking behaviors, congesting medical care facilities and putting pressure on available resources. (Garfin et al., 2020) (Tables 1–10)

Table 1 Attitudinal statements about COVID-19 and media coverage. Select all that apply. (%)

I find it hard to know what is true and what is false about COVID-19.	76
I am confused about what I should be doing in response to COVID-19.	62
I think there is too much in the news about COVID-19.	72

Source: Ofcom; our survey among 3,600 individuals conducted April 2020.

Table 2 Media usage and COVID-19 misinformation (%, yes)

Did the Chinese government create the virus as a bioweapon?	31
Can taking vitamin C prevent a person from being infected with COVID-19?	3
Do you believe in the effectiveness of hand washing and avoidance of symptomatic individuals as ways to prevent transmission of the virus?	87
Is COVID- 19 more lethal than the seasonal flu?	92
Did the U.S. government create the virus?	2

Sources: Annenberg Science Knowledge/the University of Pennsylvania and the University of Illinois at Urbana-Champaign; our survey among 3,600 individuals conducted April 2020.

Table 3 % who say they feel overwhelmed by the amount of information on the COVID-19 coverage (by age). Select all that apply. (%)

18–34 years old	47
35–54 years old	38
55+ years old	33

Sources: Gallup; Knight Foundation; our survey among 3,600 individuals conducted April 2020.

Table 4 % who say … is/are a major or minor source for news about the COVID-19 outbreak

	Major source	Minor source
News outlets		
National news outlets	59	41
Local news outlets	48	52
International news outlets	32	68
Government, community, and other sources		
Public health organizations and officials	59	41
State/Local elected officials	39	61
Trump and the COVID-19 task force	33	67
Friends, family and neighbors	24	76
Online forums or discussion groups	22	78
Community newsletter or Listservs	11	89

Sources: Pew Research Center; our survey among 3,600 individuals conducted April 2020.

Table 5 How trustworthy would you say news and information about COVID-19 on each of the following is? (Trusts = 6–10; Neither = 5; Does not trust = 0–4) (%)

	Trusts	Neither	Do not know	Does not trust
Search engines	49	28	9	14
Video sites	29	29	18	24
Social media	26	26	17	31
Messaging apps	21	22	27	30

Sources: Reuters Institute for the Study of Journalism; our survey among 3,600 individuals conducted April 2020.

Table 6 Thinking about what you are seeing on social media, which of the following sources are you getting information about COVID-19 from? Select all that apply. (%)

Directly from news media	69
Directly from official sources such as the government, WHO etc	42
Links forwarded/posted/shared from a person you know	27
Opinions from a person you know	20
Links forwarded/posted/shared from a person you don't know	8
Opinions from a person you don't know	7
I don't notice where the information is coming from	4

Sources: The University of Canberra; our survey among 3,600 individuals conducted April 2020.

Table 7 % who have seen … (of) news and information about the COVID-19 outbreak that seemed completely made up

none at all	7
not much	23
a lot	18
some	52

Sources: Pew Research Center; our survey among 3,600 individuals conducted April 2020.

Table 8 Of respondents who provided a COVID-19-related news story/claim they thought was made up, % who said it was about each topic

Creation/Origin	27
Cures for it	21
Ways to prevent it	15
How it spreads	11
How people get infected	9
Medical tests	6
Symptoms of it	5
That black people are immune to it	3
Vaccine	3

Sources: Pew Research Center; our survey among 3,600 individuals conducted April 2020.

Table 9 Which of the following, if any, would you like to see more of in news coverage? Select all that apply. (%)

	Gen Z	Millennials	Gen X	Boomers
Recovery rates	56	62	54	50
Positive stories	45	57	55	52
Local updates	41	53	52	57
Tips on how to stay healthy	36	45	45	38
Investigative reports/ Analysis on government strategies	29	44	36	29
Topics unrelated to COVID-19	33	36	32	30
Opportunities for volunteering	18	30	20	13

Sources: GlobalWebIndex; our survey among 3,600 individuals conducted April 2020.

Table 10 How much false or misleading information about COVID-19, if any, do you think you have seen on each of the following in the last week? Select all that apply. (%)

People I do not know	33
Politicians	42
News organizations	27
Government	36
People I know	17
Global health organizations	16
National health organizations	13
Scientists, doctors, experts	10

Sources: Reuters Institute for the Study of Journalism; our survey among 3,600 individuals conducted April 2020.

5. Conclusions and Implications

Incessant COVID-19-related media consumption may intensify distress and mental condition in certain groups. (Holmes et al., 2020) The news coverage of COVID-19 makes the viewers feel confused and engaged in anxiety and panic. (Dong and Zheng, 2020) Factual accurate information seeking when confronted with insecurity (Cadge et al., 2019; Hadaś-Dyduch, 2019; Lăzăroiu, 2018a, b; Nica et al., 2019; Szewieczek, 2019) is possibly an adaptive behavior, enabling individuals to make rational decisions as regards keeping themselves safe. (Wiederhold, 2020b)

Survey method

The interviews were conducted online and data were weighted by five variables (age, race/ ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. Sampling errors and test of statistical significance take into account the effect of weighting. Stratified sampling methods were used and weights were trimmed not to exceed 3. Average margins of error, at the 95% confidence level, are +/-2%. For tabulation purposes, percentage points are rounded to the nearest whole number. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

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Author Contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Scaring Ourselves to Death in the Time of COVID-19: Pandemic Awareness, Virus Anxiety, and Contagious Fear

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ABSTRACT. Despite the relevance of the relationship between pandemic awareness, virus anxiety, and contagious fear, only limited research has been conducted on this topic. Using and replicating data from GlobalWebIndex, Pew Research Center, Public Knowledge, Reuters Institute for the Study of Journalism, University of Canberra, and WHO, we performed analyses and made estimates regarding the primary harms of misinformation related to COVID-19. The results of a study based on data collected from 3,400 respondents provide support for our research model. Using the structural equation modeling, we gathered and analyzed data through a self-administrated questionnaire.

Keywords: COVID-19; misinformation; pandemic awareness; virus anxiety; contagious fear

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1. Introduction

Internet is spreading swiftly a massive quantity of uncontrolled information. Fake news may travel more rapidly than COVID-19, and bring about apprehensions and

worries. (Fiorillo and Gorwood, 2020) Extensively accessible information displayed on social media platforms by individuals across the globe determine the leading opinions, beliefs, feelings, and concerns (Adami, 2019; Byerly et al., 2019; Lăzăroiu, 2017; Mihăilă, 2017; Nica, 2017) that dominate the minds of users with regard to the COVID-19 pandemic. (Abd-Alrazaq et al., 2020) As more news is received and more develops, excess anxiety culminates in a decrease of mental capacity to make coherent decisions. (Kowalski et al., 2020)

2. Conceptual Framework and Literature Review

Social media and exaggerated reporting of the COVID-19 crisis have contributed to fearfulness and incertitude (Androniceanu, 2019; Ion-Ebrasu et al., 2020; Lobina, 2019; Mihăilă et al., 2018; Ostoj, 2019) in the viewers as regards vital health-related information. (Smith et al., 2020) The mainstream media routinely give the facts on COVID-19 pessimistically (e.g. by looking into the volume of patients infected and people who pass away rather than persons who get better or experience mild symptoms), intensifying negative emotions and inducing otherwise ignored risks. (Bavel et al., 2020) By cross-checking the consumed news with reliable sources, viewers can suppress the feeling of ineptitude brought about by the excess of COVID-19-related information, and detach from adverse environment. (Wiederhold, 2020)

3. Methodology and Empirical Analysis

Using and replicating data from GlobalWebIndex, Pew Research Center, Public Knowledge, Reuters Institute for the Study of Journalism, University of Canberra, and WHO, we performed analyses and made estimates regarding the primary harms of misinformation related to COVID-19. The results of a study based on data collected from 3,400 respondents provide support for our research model. Using the structural equation modeling, we gathered and analyzed data through a self-administrated questionnaire.

4. Results and Discussion

Psychological distress developing out of persistent media exposure to the COVID-19 outbreak brings about instant discomfort in viewers enduring atypical social and economic consequences (Balica, 2019; Ionescu, 2019; Lyakina et al., 2019; Milward et al., 2019) and long-term physical and mental health repercussions. (Garfin et al., 2020) The excessive quantity of questionable news headlines and inaccurate media reports leads to fear- and anxiety-based responses. (Ullah and Amin, 2020) Trustworthy reporting of what viewers learn should not distort the fluid and incomplete state of their knowledge. (Mesa Vieira et al., 2020) (Tables 1–10)

Table 1 The role of news during COVID-19 pandemic. Select all that apply. (%)

The news has provided an important topic of conversation with my friends, family and colleagues.	82
The news has made me feel more anxious.	78
The news has prompted me to stock up on essentials.	75
The news has helped me pass the time.	57
The news has helped me feel more connected to my community.	62
The news has helped me deal with feelings of loneliness and isolation.	43

Sources: University of Canberra; our survey among 3,400 individuals conducted April 2020.

Table 2 The type of information I need the most, relates to… Select all that apply. (%)

symptoms of COVID-19.	86
personal stories from others about how they cope.	78
scientific progress in development of a vaccine against COVID-19.	92
scientific progress in development of treatment for COVID-19.	90
how I can personally prevent spread of the disease.	79
how I can take care of a person who is in a risk group.	73
how I can best take care of my children's school education.	76
details on travel restrictions.	72

Sources: WHO; our survey among 3,400 individuals conducted April 2020.

Table 3 Which, if any, of the sources below do you believe has trustworthy information about COVID-19? Select all that apply. (%)

	Gen Z	Millennials	Gen X	Boomers
WHO website	51	61	65	54
Government website	36	51	52	45
Emails/Newsletters from the government	34	47	43	39
News channels	34	39	42	37
Emails/Newsletters from health bodies	28	42	43	35
News websites	31	38	36	27
Scientific articles	28	36	31	31
News bulletins	15	30	32	29
International news	32	37	20	19
Radio	22	28	25	21
Expert blog posts	24	27	17	14
News shared on social media	14	29	13	7
News in physical magazines/newspapers	13	26	15	17
Word-of-mouth from friends/family	12	26	16	13
Foreign governments' websites	13	24	13	10
Video sites	13	20	10	4
Podcasts	7	18	11	6
Updates from brands	6	17	7	3
Webinars	2	11	6	3

Sources: GlobalWebIndex; our survey among 3,400 individuals conducted April 2020.

Table 4 The primary harms of misinformation related to COVID-19 are likely … Select all that apply. (%)

fear mongering and increasing panic and angst.	78
threat to the physical safety of individuals.	18
limiting the effectiveness of official efforts to curb the pandemic.	36
fostering racism.	22

Sources: Public Knowledge; our survey among 3,400 individuals conducted April 2020.

Table 5 % who say the news media have … about the COVID-19 outbreak.

exaggerated the risks greatly	35
exaggerated the risks slightly	27
gotten the risks about right	20
not taken the risks quite seriously enough	11
not taken the risks seriously at all	7

Sources: Pew Research Center; our survey among 3,400 individuals conducted April 2020.

Table 6 % who are following national news related to the COVID-19 outbreak about each topic very closely. Select all that apply.

Economic impact	92
Advice from national health organizations/CDC	88
Health impact on people like me	84
Number of cases and deaths in the U.S.	83
Federal government actions	78
Ability of U.S. hospitals to treat patients	85

Sources: Pew Research Center; our survey among 3,400 individuals conducted April 2020.

Table 7 % who say keeping up with news about the COVID-19 outbreak …

makes them feel better emotionally	25
does not change their emotions	23
makes them feel worse emotionally	52

Sources: Pew Research Center; our survey among 3,400 individuals conducted April 2020.

Table 8 % who have experienced a change in mental health in the past 3 months by primary social media platform used for COVID-19 news

	Worse	About the same	Better
Reddit	61	19	20
Facebook	44	24	32
Twitter	46	20	34
YouTube	37	22	41

Sources: Flixed; our survey among 3,400 individuals conducted April 2020.

Table 9 Attitudes towards media coverage of the COVID-19 pandemic: To what extent do you agree with the following statements? (yes, %)

The news media has helped me understand the pandemic.	64
The news media has explained what I can do in response to the pandemic.	68
The news media has exaggerated the pandemic.	39

Sources: Reuters Institute for the Study of Journalism; our survey among 3,400 individuals conducted April 2020.

Table 10 % who say they have heard a lot about each of the following claims about the COVID-19 outbreak. Select all that apply. (%)

Hydroxychloroquine as a treatment	52
Plasma transfusions as a treatment	44
The virus going away in warmer weather	62
Vitamin C as a prevention	32
Connection between 5G and the virus	39
Diluted bleach (MMS) as a treatment	6

Sources: Pew Research Center; our survey among 3,400 individuals conducted April 2020.

5. Conclusions and Implications

The excess of COVID-19-related news may generate anxiety and panic in the viewers. (Hao et al., 2020) By reducing sharing of alternative facts, users' risk of exposure to fake news and intensification of panic is mitigated. (Holmes et al., 2020) The harnessing of instant-messaging technology and smartphones makes the information disseminate swifter (Bratu, 2019; Kearney et al., 2019; Meyers et al., 2019; Mishchuk et al., 2019; Pickard et al., 2019) and amplifies the psychological disorders of public. (Dong and Zheng, 2020) Diminishing the proliferation of fake news is as relevant to maintain social comfort as fighting COVID-19 infection. (Guitton, 2020)

Survey method

The interviews were conducted online and data were weighted by five variables (age, race/ ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. Sampling errors and test of statistical significance take into account the effect of weighting. Stratified sampling methods were used and weights were trimmed not to exceed 3. Average margins of error, at the 95% confidence level, are +/-2%. For tabulation purposes, percentage points are rounded to the nearest whole number. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

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Author Contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The Viral Power of Fake News: Subjective Social Insecurity, COVID-19 Damaging Misinformation, and Baseless Conspiracy Theories

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ABSTRACT. Employing recent research results covering the viral power of fake news, and building our argument by drawing on data collected from Carleton University, GlobalWebIndex, Pew Research Center, Public Knowledge, Statista, and the University of Canberra, we performed analyses and made estimates regarding conspiracy theories and incorrect scientific information about COVID-19. Structural equation modelling was used to analyze the collected data.

Keywords: fake news; damaging misinformation; COVID-19; conspiracy theories; stress

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1. Introduction

An unexpected and incessant flood of falsehoods and alternative facts in news reports concerning the COVID-19 outbreak may bring about fear, anxiety, and

stress. (Kumar and Nayar, 2020) Directing attention to trustworthy sources of information is pivotal in curbing fake news and conspiracy theories that may amplify panic and generate massive distress. (Kelly, 2020) The relentless news coverage of COVID-19-related events constitutes an important stressor for persons with pre-existing mental health issues. (Reger et al., 2020)

2. Conceptual Framework and Literature Review

The rise of social media and the Internet has enabled the swift and effortless dissemination of information (Challoner and Popescu, 2019; Lăzăroiu, 2017; Nica, 2019; Vilchez, 2019), generating confusion and anxiety when inaccurate news is transmitted online. (Tan et al., 2020) Mainstream media coverage has given prominence to COVID-19 as an unparalleled threat, intensifying panic, stress, and insecurity. (Kim and Su, 2020) COVID-19 panic buying may result in the unavailability of resources. (Roy et al., 2020) Viewers with significant concerns may pursue additional media coverage of the COVID-19 crisis, amplifying their stress reactions more thoroughly. (Garfin et al., 2020) Erroneous beliefs may be strengthened by the distorted consent (Bacalu, 2018; King, 2019; Nica, 2018; Tuffnell et al., 2019) that is generated when news is distributed on social media platforms, suggesting that recurrent messages are likely to be regarded as legitimate. (Van den Broucke, 2020) The medical community should identify more convincing manners to make information known and engage the viewers, taking into account the notable extent and swiftness of news flow facilitated by social media. (Wong et al., 2020)

3. Methodology and Empirical Analysis

Building our argument by drawing on data collected from Carleton University, GlobalWebIndex, Pew Research Center, Public Knowledge, Statista, and the University of Canberra, we performed analyses and made estimates regarding conspiracy theories and incorrect scientific information about COVID-19. Structural equation modelling was used to analyze the collected data.

4. Results and Discussion

News narratives highlighting panic disorder may generate unethical phenomena, promoting the selfishness and competitiveness that convert judicious arrangements (Asimopolos et al., 2020; Ionescu, 2018a, b; Mihăilă, 2017; Trettin et al., 2019) into socially impaired hoarding and weakening the sense of shared objectives which enable individuals supporting one another throughout the COVID-19 pandemic. (Bavel et al., 2020) A lot of patients are spending inordinate time watching television and inspecting online media sources, thus intensifying their obsessive-compulsive disorder and anxiety. (Fineberg et al., 2020) (Tables 1–11)

Table 1 The primary types of misinformation related to the COVID-19 pandemic are … Select all that apply. (%)

potential cures.	79
factors that contribute to disease transmission.	72
conspiracies about the root cause of the disease.	69

Sources: Public Knowledge; our survey among 4,200 individuals conducted April 2020.

Table 2 % who say it is most likely COVID-19 …

came about naturally.	74
developed intentionally in a lab.	20
made accidentally in a lab.	5
does not really exist.	1

Sources: Pew Research Center; our survey among 4,200 individuals conducted April 2020.

Table 3 Conspiracy theories and incorrect scientific information about COVID-19 (yes, %)

COVID-19 was engineered as a bioweapon in a Chinese lab and released into the general population.	18
COVID-19 is not a serious illness but is being spread to cover up harmful health effects associated with exposure to 5G wireless technology.	6
Drugs such as hydroxychloroquine are effective in treating patients who have been infected with COVID-19.	20
Regularly rinsing your nose with a saline solution can help protect individuals from infection with COVID-19.	10
Can you easily distinguish conspiracy theories and misinformation from factual information about COVID- 19?	62

Sources: Carleton University; our survey among 4,200 individuals conducted April 2020.

Table 4 News avoidance by COVID-19 misinformation experience (%)

Have encountered misinformation a great deal/a lot	77
Have encountered misinformation somewhat/not so much/not at all	23

Sources: University of Canberra; our survey among 4,200 individuals conducted April 2020.

Table 5 Which of the following social media platforms, if any, are you using for up-to-date news/information about COVID-19? Select all that apply. (%)

	Gen Z	Millennials	Gen X	Boomers
Facebook	43	54	44	34
YouTube	39	41	28	15
Instagram	38	37	22	6
Twitter	30	28	26	15
WhatsApp	32	38	19	1
Snapchat	21	19	6	0
Telegram	9	21	7	0
Reddit	12	18	3	1
LinkedIn	6	15	5	2
Other	6	3	4	7
I don’t trust social media content about COVID-19	24	28	35	49

Sources: GlobalWebIndex; our survey among 4,200 individuals conducted April 2020.

Table 6 % who have seen or read fake news about COVID-19 in the past 2 weeks (by age group and gender)

Men	59
Women	54
18–30	56
30–44	59
45–59	52
60+	44

Sources: Statista; our survey among 4,200 individuals conducted April 2020.

Table 7 % who say the following groups provide the most up-to-date and accurate information about COVID-19 on social media Select all that apply.

	Gen Z	Millennials	Gen X	Boomers
Official government accounts	52	61	50	44
Health bodies/Hospitals	45	49	52	39
Hospital staff (e.g. doctors/nurses)	40	41	45	52
Official news media accounts	38	47	42	30
Journalists	17	24	19	8
Posts from friends/family	11	22	12	10
Celebrities/Well-known individuals	8	14	8	4
Bloggers/Vloggers	7	16	7	3
Brands' accounts	5	12	7	2
Other	3	5	4	3
I don't trust social media content about COVID-19	17	12	16	24

Sources: GlobalWebIndex; our survey among 4,200 individuals conducted April 2020.

Table 8 When you came across false or misleading information, what (if anything) did you do after seeing it? Select all that apply. (%)

I stopped paying attention to information shared on social media by people I do not trust.	76
I searched a number of different sources to see whether it was accurate.	62
I discussed the information with other people I trust.	54
I started using established news sources.	70
I used a fact-checking website.	23
I stopped using or blocked the source because I was unsure about the accuracy of the information.	14
I forwarded or shared it with other people.	19
I made a complaint to the information provider.	5
Did nothing.	22

Sources: University of Canberra; our survey among 4,200 individuals conducted April 2020.

Table 9 % who …

	very	fairly	somewhat
are following news about COVID-19 … closely.	59	29	22
think the media have covered COVID-19 … well.	54	39	17

Sources: Pew Research Center; our survey among 4,200 individuals conducted April 2020.

Table 10 % of U.S. adults who think the news media's coverage of the COVID-19 outbreak is …

more positive than it should be.	17
neither too positive nor too negative.	23
more negative than it should be.	60

Sources: Pew Research Center; our survey among 4,200 individuals conducted April 2020.

Table 11 % who say they need …

to stay tuned in to COVID-19 news	36
to take breaks from COVID-19 news	64

Sources: Pew Research Center; our survey among 4,200 individuals conducted April 2020.

5. Conclusions and Implications

The enhancement of Internet communication significantly intensifies the accessibility and circulation of knowledge (Androniceanu, 2019; Indartono and Faraz, 2019; Lăzăroiu et al., 2018; Popescu et al., 2018; Wei, 2019), while being instrumental in the advancement and spread of COVID-19 misinformation or alternative facts. (Lai et al., 2020) A stream of messages containing inaccurate information as regards COVID-19 is being transmitted swiftly via social media and messaging apps. (Cathal and Michelle, 2020) Televised broadcasts featuring psychologists and physiatrists may diminish viewers' COVID-19-related mental stress and anxiety. (Bilal et al., 2020)

Survey method

The interviews were conducted online and data were weighted by five variables (age, race/ ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. Sampling errors and test of statistical significance take into account the effect of weighting. Stratified sampling methods were used and weights were trimmed not to exceed 3. Average margins of error, at the 95% confidence level, are +/-2%. For tabulation purposes, percentage points are rounded to the nearest whole number. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

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Author Contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The Fake News Sociology of COVID-19 Pandemic Fear: Dangerously Inaccurate Beliefs, Emotional Contagion, and Conspiracy Ideation

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ABSTRACT. This article presents an empirical study carried out to evaluate and analyze the relationship between dangerously inaccurate beliefs, emotional contagion, and conspiracy ideation. Building my argument by drawing on data collected from The Economist, Gallup, GlobalWebIndex, Knight Foundation, Ofcom, Pew Research Center, Reuters Institute for the Study of Journalism, University of Canberra, and YouGov, I performed analyses and made estimates regarding the main sources of false or misleading information about COVID-19. Data collected from 4,600 respondents are tested against the research model by using structural equation modeling.

Keywords: fake news; misinformation; COVID-19; pandemic fear; anxiety; stress

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1. Introduction

Mainstream media entities are creating suspenseful headlines, generating panic-like anxiety amongst the viewership, by making suppositions about the imaginable health impact of COVID-19 and by emphasizing its terrible consequences. (Mian and Khan, 2020) Nearly all the COVID-19-related news is mainly discouraging and exasperating. Consistently shocking statistics are associated with dreadful rumors. As viewers are persistently exposed to such information, their degree of anxiety escalates. (Moghanibashi-Mansourieh, 2020) Major journalism organizations should give the facts on the developing COVID-19 crisis truthfully and competently, ensuring that their public receives relevant and rigorous information. (Laupacis, 2020) In social media, fake news is disseminated considerably more than fact-based information. (Pulido et al., 2020)

2. Conceptual Framework and Literature Review

Mainstream media should broadcast authentic COVID-19-related news instantaneously. (Driggin et al., 2020) When information from public officials or health experts is inadequate or is sporadically reported (Hayhoe et al., 2019; Lăzăroiu, 2018a, b; Nica, 2017; Swadzba, 2019), viewers may be exposed to particular social and media deceptive messages. (Torales et al., 2020) If authoritative and unambiguous statements are not formulated condemning and discrediting fake news, then the consequences on the news consumers may be pernicious. (Mian and Khan, 2020) As its recipients sometimes cannot discern factuality from fabrication (Burwell et al., 2018; Lăzăroiu, 2017; Mihăilă et al., 2018; Sion, 2018), COVID-19 misinformation leads to uncertainty and anxiety. (Ko et al., 2020) Beyond repercussions on physical health from the escalated stress reactions, media-fueled trauma may burden healthcare facilities that already concentrate on a large volume of COVID-19-infected patients. (Garfin et al., 2020) Televised sessions with former cases who are recuperating from the COVID-19 disease may assist the viewers in alleviating their stress, panic, and fear of passing away. (Bilal et al., 2020)

3. Methodology and Empirical Analysis

Building my argument by drawing on data collected from The Economist, Gallup, GlobalWebIndex, Knight Foundation, Ofcom, Pew Research Center, Reuters Institute for the Study of Journalism, University of Canberra, and YouGov, I performed analyses and made estimates regarding the main sources of false or misleading information about COVID-19. Data collected from 4,600 respondents are tested against the research model by using structural equation modeling.

4. Results and Discussion

Mainstream media must act adequately, broadcasting factual COVID-19-related information and invalidating fake news narratives posted on social media platforms. (Legido-Quigley et al., 2020) Dissemination of fake news overwhelms trustworthy sources and thus leads to increased public confusion, sooner or later giving rise to ampler expansion and counterproductive reduction of COVID-19 transmission. (Mian and Khan, 2020) Mainstream media entities documenting about the undersupply of resources and indispensable products covering ordinary needs to a greater extent magnifies consumer panic buying. (Roy et al., 2020) Cutting-edge tools are instrumental in transmitting trustworthy news while balancing out delusions, hoax news, and rumors. (Okyere et al., 2020) The decline in unmediated contact as a result of COVID-19 may diminish cross-partisan behaviors and information circulation. (Bavel et al., 2020) Poor mental health of former patients may generate a compulsive pursuance of COVID-19 information to reduce their anxiety. (Ko et al., 2020) (Tables 1–8)

Table 1 What do you think is the main source of false or misleading information about COVID-19 in the U.S.? (%)

Social media websites and apps	34
The Trump administration	36
Mainstream national news	19
State elected officials (governors)	4
Friends and family	4
Local news	3

Sources: Gallup; Knight Foundation; my survey among 4,600 individuals conducted April 2020.

Table 2 False or misleading information about COVID-19 that respondents have come across. Select all that apply. (%)

Drinking more lemon juice	71
Drinking water more frequently	68
Eating warm food/drink and avoiding cold food/drink	44
Gargling with salt water	52
Increasing use of natural remedies	76
Inhaling steam	43
Putting clothes in the sun or another warm place to disinfect them	76
Theories linking the origins or causes of COVID-19 to 5G	72

Sources: Ofcom; my survey among 4,600 individuals conducted April 2020.

Table 3 Experience of misinformation a lot or a great deal by type of news consumer. (%)

News access	
Heavy news consumer	28
Light news consumer	22
Change in consumption	
Increased	29
Not changed	12
Decreased	33
Concern about COVID-19	
Concerned	32
Not concerned	23

Sources: University of Canberra; my survey among 4,600 individuals conducted April 2020.

Table 4 Of respondents who provided a COVID-19-related news story/claim they thought was made up, % who said it was about each topic

That the risk is high, generally	23
That there is a need to stock up on goods	5
That the economy will suffer	2
That the risk is low, generally	14
That the virus is a hoax/lie	3
That the virus is intended to interfere with the presidency/election	2

Sources: Pew Research Center; my survey among 4,600 individuals conducted April 2020.

Table 5 The following statements have been said about COVID-19. To the best of your knowledge, do you think each one of them is true or false? (%)

	True	False	I do not know
COVID-19 can be transmitted in areas with hot weather. (correct)	79	10	11
Eating garlic can help prevent infection with COVID-19.	3	75	22
Older people are more susceptible to becoming seriously ill from COVID-19. (correct)	92	4	4
Antibiotics are effective in treating COVID-19.	12	61	27
COVID-19 was made in a laboratory.	21	53	26

Sources: Reuters Institute for the Study of Journalism; my survey among 4,600 individuals conducted April 2020.

Table 6 How closely are you following the news about COVID-19? (%)

	Very closely	Somewhat closely	Not very closely	Not following at all
Gender				
Male	56	34	8	2
Female	59	32	7	2
Education				
HS or less	56	34	7	3
Some college	53	39	6	2
College grad	72	22	4	2
Postgrad	76	21	3	0
Income				
Under $50K	46	42	9	3
$50-100K	58	37	4	1
$100K or more	71	25	4	0
Age				
18–29	46	42	10	2
30–44	59	30	9	2
45–64	61	35	3	1
65+	64	32	3	1
Race				
White	57	36	5	2
Black	55	32	10	3
Hispanic	59	31	8	2
Other	43	42	12	3

Sources: The Economist; YouGov; my survey among 4,600 individuals conducted April 2020.

Table 7 How much do you think made-up news and information leave U.S. citizens confused about the basic facts of the COVID-19 outbreak? (%)

A great deal	63
Some	23
Not too much	12
Not at all	2

Sources: Pew Research Center; my survey among 4,600 individuals conducted April 2020.

Table 8 To what extent do you agree or disagree with the following statement: "I would pay for a news source to keep me accurately informed about COVID-19"? (%)

	Gen Z	Millennials	Gen X	Boomers
Strongly disagree	29	25	26	38
Somewhat disagree	19	17	14	18
Neutral	23	20	27	24
Somewhat agree	22	19	23	11
Strongly agree	7	19	10	9

Sources: GlobalWebIndex; my survey among 4,600 individuals conducted April 2020.

5. Conclusions and Implications

The systematic tremendous news exposure to the COVID-19 pandemic has resulted in intensification of anxiety in certain patients with psychiatric disorders. (Moesmann Madsen et al., 2020) News consumption from trusted sources may make individuals keep away from delusions, rumors, and alternative facts. (Fineberg et al., 2020) Inaccurate information in messages posted on social media has considerably diverted the viewers' attention (Kovacova et al., 2019; Mihăilă, 2017; Popescu and Ciurlău, 2019; Walker and Lovat, 2018) from the evidence-based carefulness (Kohlhoffer-Mizser, 2019; Lingchen, 2019; Nica, 2018; Varlam et al., 2020) that health experts are promoting. (Cathal and Michelle, 2020)

Survey method

The interviews were conducted online and data were weighted by five variables (age, race/ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. Sampling errors and test of statistical significance take into account the effect of weighting. Stratified sampling methods were used and weights were trimmed not to exceed 3. Average margins of error, at the 95% confidence level, are +/-2%. For tabulation purposes, percentage points are rounded to the nearest whole number. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and Materials Availability

All research mentioned has been published and data is available from respective outlets.

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