Psychology of Bilingualism and Multilingualism
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Hello and welcome to the course Introduction to The Psychology of Bilingualism and Multilingualism. I am Dr. Ark Verma from the Department of Cognitive Sciences at IIT Kanpur. We are talking about comprehension processes in bilinguals and multilinguals and in that extent one of the very interesting things that has happened is the evolution of some of these models which has been adopted from monolingual models of word recognition. One of the most influential models that have sought to explain the processes of bilingual lexical access has been the bilingual interactive activation model which was developed by Dijkstra and colleagues in the 1998s. This was a connectionist computational model of visual word recognition in bilinguals and concerns an extended version of the interactive activation model which was earlier instituted by McClelland and Rumelhart way back in the 1980s.

Now the BIU model has been shown to be able to stimulate the observed homograph effects that we are discussing in the previous lectures despite the fact that the model does not really you know represent word meanings. Also the model has been able to simulate some of the monolingual behavioural data that McClelland and Rumelhart had model in their initial IA model. The BIA model contains four levels of representation units or nodes that represent visual letter features, letters, the orthographic forms of whole words and also language information. Let us have a look at this model.

This one on the left is the bilingual interactive activation model. You can see that it has language nodes, it has you know language information Dutch or English, it has words from Dutch and English, it has a letter level, it has a feature level as well. You can see the flow of information, how the flow of information would be when you present some input the features will get activated which are present in the input. These features will in turn activate the letters that contain those features and not the letters that do not contain those features. And then words from both Dutch and English that contain those same letters.

Remember Dutch and English are written using a very similar orthography. And then you can see that there is this language node whereas the Dutch words feed on to Dutch language nodes, English words feed on to English language nodes. You can see that the Dutch language inhibits all the word nodes of English and the English language inhibits all the word nodes of Dutch. These rounded connections are inhibitory connections whereas these connections with the arrows at the end are called excitatory connections. This is a brief overview of the diagram.

Let us go further and explore the processing in this model in some more detail. Now more specifically in the BIA model, the bilinguals two language two languages share the feature and the letter nodes. So for example, given that there is a huge similarity of script between Dutch and English and this model was initially developed using Dutch and English data. You can see that it is obviously possible that the features and the letters are common and shared across both these languages. However, you can see that the word nodes are organized in language subsets.

You can look at here and you can see that the Dutch nodes are clustered on this side whereas the English word nodes are clustered on the right side. Also you can see that the layer of language nodes contains Dutch just two nodes, one for each language. Now the processing in this model is assumed to be interactive like we have talked about the spreading interactive activation model by Gary Dell whereas speech perception is, where speech production is concerned. This model, the BIA model is also interactive in that representations at one particular level can interact in an excited or inhibitory fashion with the adjacent levels at the higher on the lower end. Now activations are instantiated through excitatory connections whereas inhibitions are instantiated through inhibitory connections.

Further, in addition to excitatory and inhibitory connection between levels or from the top or the bottom, the model also assumes inhibitory connections between all the orthographic word form nodes at the same level, the phenomena which is referred to as lateral inhibition. You can see here that English words would inhibit English words here and so on and so forth. So, the idea is that the words basically in order to counter for competition will actually suppress all the other words that are not being activated by the inputs from the letter level. Now, when a visual word is presented, the BIA model first activates the feature nodes that correspond to the input, say for example horizontal, vertical, slanting or curved lines. The feature nodes in turn feed activation into the layer of letter nodes wherein it excites the nodes for letters which contain these features and inhibits the nodes for letters that do not carry these activated features.

So, it is like serially this is happening. Further, the activated letter nodes would inhibit the or activate the word nodes that contain these letters depending on whether you know the word nodes contain these letters or not. For instance, let us take an example. When the English word sand is presented to the model, it will activate the letters S, A and D, we are the feature level nodes and in turn will activate the word node corresponding to sand. However, it will also activate nodes for similar words like hand, seine and sank which actually share a lot of letters with the presented stimulus.

Now, you will also see that in this model word nodes for slightly less similar words like salt, wind and sin will also get activated, but the activation will be to a slightly lower extent because see these words carry some of these letters that are presented in the actual stimulus, but not all of them. So, while words like hand which share three letters with the word sand will get more activation, the words like salt which only shares two letters with the word sand will get slightly less activated. This is basically this is something that we call graded activation. However, the activation of these you know less similar words will be nullified through the inhibitory effect of mismatching remaining letters which is being manifested through the lateral inhibition process. In importantly activated letter nodes will activate word nodes corresponding to you know corresponding in both languages.

So, in a Dutch English bilingual the letter nodes that are activated will also activate excite word nodes for Dutch words like zan and man and in English we have seen hand, sank etcetera are getting activated. So, these activated word nodes going further will transmit activation to the node of the corresponding language at which moment the letter starts to inhibit word nodes of other language. So, once the language node is activated it starts sending inhibitory inhibitory connection to the words from the other language. In some sense if an English word is presented its features, its letters and its words are activated and then when it feeds the activation to the English node language node that English language node will try and suppress the all the you know word nodes presented from Dutch. Basically this would try to create some sort of a selectiveness for processing stimuli of the given language.

Now in more detail if and when the activation of a word level reaches the recognition threshold is not only going to be determined by the match between the stimulus and the word node in terms of shared letters, but also by a number of other variables. For instance the number of activated word nodes that are competing with another you know with one another during the recognition process will also affect this activation. For example, and this is basically referred to in by terms of neighborhood you know when you are presenting the stimulus stand there are also neighbors like sank, hand and so on which will also share some of the activation that is being present in the system and therefore, it will take slightly more time for the stimulus stand to get you know to reach to get its activation up till the threshold level. Also the level of activation of the word node when it is in resting state is plays a very important factor. Now, a words you know activation level in its resting state is basically determined by the frequency of a given word or the frequency of use or encounter of a given word.

Words that are high in frequency and are encountered more frequently typically would tend to have a higher baseline activation than words that were basically you know encountered very rarely. For example, the word juxtaposition would obviously have lower frequency and lower baseline activation than the word between for example, because which is the it is something that we use much more often and is much simpler to use in that sense. Now, Dijkstra and Van Hoven postulate two orthographic word node representations for inter lexical homographs. Now coming to how does this model account for the in you know homograph effect. So, Dijkstra and Van Heuven postulate two orthographic word nodes for inter lexical homographs one present in each language.

Say for example, if I am presenting a word room which is an inter lexical homograph for Dutch and English because room means you know the space in English whereas, room means cream in Dutch. Now this word basically coming from feature level and letter level will lead to common activations or activations to common targets, but it will have one entity in Dutch and the other entity in English. Now so what will happen further is that both of these you know representations will get activated when an inter lexical homograph like room is presented to the system. On the contrary if a non homograph is presented there will be only one node in each in one of the two languages and overall activation will be slightly lower. So, Dijkstra and Van Heuven try to explain the you know inter lexical homograph effect by the point that because homographs have representations in both the languages they might be recognized faster as compared to you know unilingual control words which have representation only in one of these two languages.

An alternate proposal also given by Dijkstra and colleagues was that the inter lexical homographs were not to be represented in both the languages across two separate word nodes, but would actually share one and the same word node which will be common to both the languages. However, they sort of discarded this possibility later because it did not confirm with the obtained data in later experiments. Now it would seem that the BIA model can in fact, deal with the obtained out of context homograph effects. However, how would it account for different pronunciations of homographs in the two languages? So, there are a lot of times you know as I said the word room, the word room in English is pronounced differently and it is pronounced very differently in Dutch all right. So, since the BIA model does not contain phonological representations it is not really equipped to explain these effects.

Also the BIA model would fail to account for the role of natural language meaning in ambiguity resolution because as I said in the start it also does not represent meanings other words it is basically represents features, letters, word nodes and language nodes. For this reason Dijkstra and Van heuven proposed a different and slightly more elegant model by the name of semantic orthographic phonological interactive activation model or known more famously by its acronym SOPHIA. This model encompasses all three levels of representation. Let us look at this in more detail. The SOPHIA model carries two additional layers between the original letter level and the word levels.

There is a level of orthographic clusters and a level of orthographic syllables. So, in all there are three orthographic units one representing just letters, other representing letter clusters like bigrams and so on and the third representing syllables which are combinations. In this model phonology is also represented in four analogous levels of nodes that represents phonological units of different sizes. You can see here that you have sublexical orthography and sublexical phonology represented in this model along with semantics and along with the information about language nodes which is much more detailed and much more nuanced than how it was done in the BIA model.

Let us move on. The processing assumptions of SOPHIA are slightly in in some sense very similar to the BIA model including those of the excitation and inhibition of adjacent levels as well as inhibition at the same level of representation. So, both excitatory and inhibitory connection across levels is possible just like in a cascaded model also at the same time literal inhibition is a possibility in this model. Here although the orthographic units can actually activate the phonological units and vice versa. For instance for a given word presentation the orthographic node for this word would activate the phonological form of the word that is you know the pronunciation of it. Notably SOPHIA is just not an extension of the BIA model, but it differs crucially from the same in a few respects.

For example, whereas the BIA model has both excitatory and inhibitory connections from a language node to all the word nodes of a given language in this model these connections have been removed. So, you can see here you cannot see the language nodes suppressing you know the candidates of either language. Now since this inhibitory you know connections from language nodes to words of the other language actually were serving in a very important purpose in the BIA model. Their removal actually has warranted you know alternative explanations. One of these explanations has been offered via understanding or explaining the language switching effect.

The language switching effect is basically the finding that words preceded by words of the same language are responded to faster than when they are preceded by words of another language. Say for example, you are giving a language switching task where you have to name thing. So, the words come English, English, English and then Hindi. So, then words following English words following English words would be named faster or responded to faster than English words following a Hindi word. Now, while the SOPHIA model does not explicitly deal with the language switching effect a future rendition of this model which is the BIA plus model tries to account for the same by adding a task decision system to the SOPHIA 's word identification account for the same.

This task decision system according to Dijkstra and Van Heuven is sensitive to extra linguistic influences such as the participants expectancies. Remember Grosjean's language mode theory. So, where you know what is the requirement of the task, what is the setting of the task, what is the you know probabilities of encountering a word from the other language. Some of these expectancies may actually be expected and research has shown these actually you know affect the way a participant performs the lexical decision task especially when the task is involving words from both the languages. So, the word identification system however only is affected by linguistic factors such as lexical, semantic and syntactic information.

So, in some sense you can see that the BIA plus model has a task decision system and it has a word identification system. Whereas this word identification system is basically working only on linguistic information, the task decision system is sensitive to task requirements and participants expectancies and the other factors as well. Interestingly, let us look at how the authors have attributed the homograph effect you know to some of these changes made in the newer model. For instance in terms of the BIA model, the homograph effects were attributed to the processes of activation and innovation within the lexicon and due to its own structural characteristics basically having an internal locus of control. However, in the BIA plus model they attribute the homograph effects to external control basically to external factors such as you know task demands and participant expectancies etcetera.

Now, moving forward an important aspect of the functioning of the BIA model has been the memory representations of the so called neighbors that we just saw. Neighbors are typically words that share you know aspects of phonology or orthography with the target stimulus word, alright. Now, the neighbors actually are supposed to get excited or activated irrespective of their language membership. How do these models account for that? Now according to the BIA model, a complete form overlap between the input and the information specified in the word notes is not really required for having a word note become activated from input. Hence, words having partial overlap that is these neighbors like hand and sank will also get activated when you presenting the input such as the word sank.

For instance, monolingual but this neighborhood effect or this you know the amount of neighbors that are getting activated has also been known to affect the word recognition performance of participants. For instance, monolingual neighborhood studies have shown that the time of visual word recognition for words that have you know depends upon the words frequency, but also the neighborhood sizes of a given word. These findings have also motivated bilingual researchers to account for the neighborhood effect although the pertinent question has been whether neighbors from just one or both these both the languages of a bilingual will become activated. Incidentally, set of cross language neighborhood studies have provided some you know insight into this idea. For instance, Granger and Dijkstra used French-English bilinguals to perform an English lexical decision task to three types of English target words.

Target words mainly patriot words that had more neighbors in the given language which is target language which is English, traitor words that had more you know neighbors in the non-target language such as French and neutral words that had almost the same number of neighbors in both French and English. These three group of words were actually matched for frequencies. So, the only critical factor differentiating between them was whether they had neighbors in the target language English or they had neighbors in the you know non-target language that is French or they had equal number of neighbors in French and English. The data actually showed that there was indeed an influence of the relative number of neighbors. Participants were shown to be fastest in the patriot condition followed by the neutral condition and they were slowest in the traitor condition.

This tells us that the amount of neighbors activated in the French or the non-target language here was actually having an influence on the participants response times. In another study by Bijelac-Babic, Biardeu and Grainger which they conducted with French-English bilinguals French target words preceded by orthographically similar mass primes were responded to more slowly than target words preceded by orthographically dissimilar primes. However, when the prime and target were from different languages this inhibitory effect was only observed for bilinguals. Again this tells us that in some in some sense the participants are activating word candidates from the other language. The combination of these results were taken to suggest that the source of this orthographic priming was lexical.

However, for bilinguals the effect extended to the orthographically similar words in the non-target language as well. Now, these findings together suggest that there is certainly a level of co-activation in the non-target language as well although it may be moderated by a bilingual degree of command over the non-target language. That is all that I wanted to share with you in this lecture. Let us meet in the next lecture for more. Thank you.