**Multimodal Perception: Part 2**
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**Multimodal Dual Tasks**

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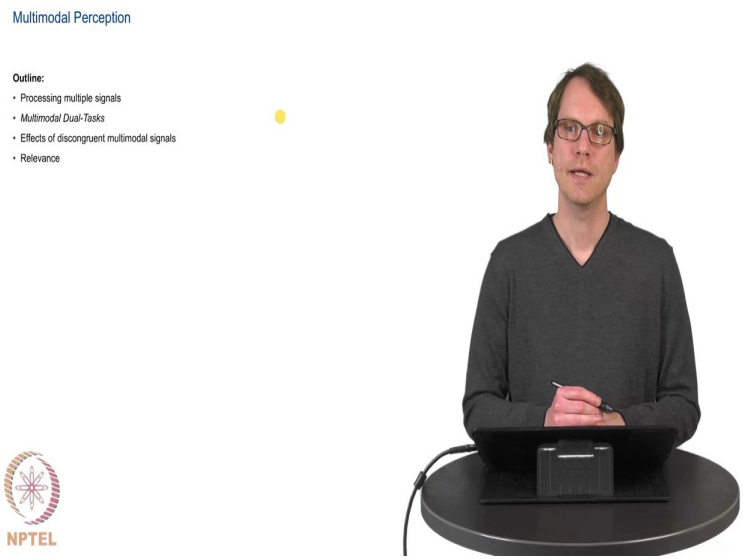


As I said earlier, humans have different cognitive resources to deal with different modality input. This not, does not only support us by processing multimodal input from the same source like the same object or the same location or event, it also helps us to process information from dual tasks or several inputs, several origins.

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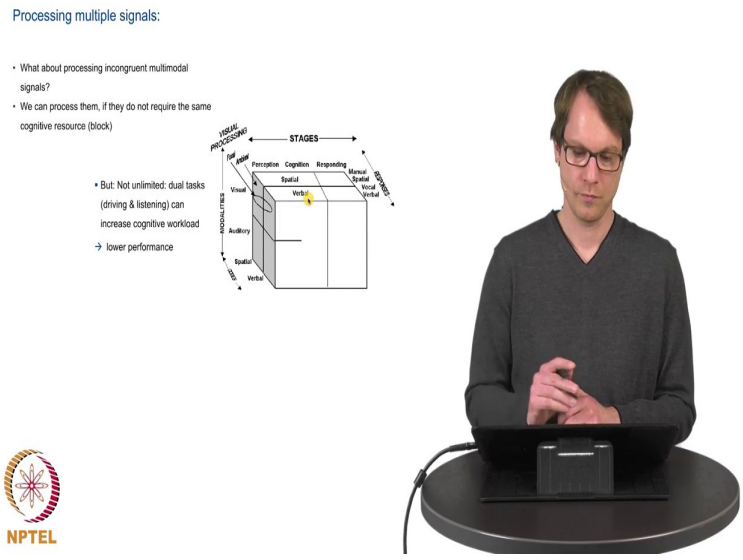


For example, here is a model by Wickens.

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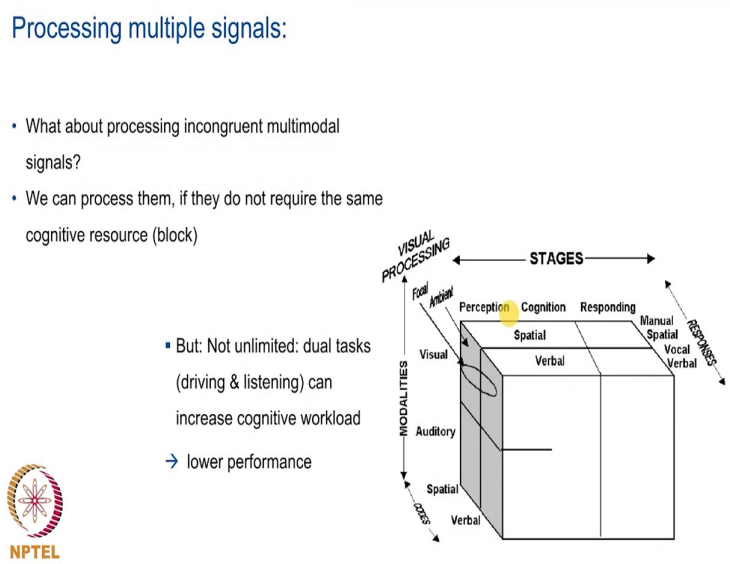


You can see in this cube the different resources, here are

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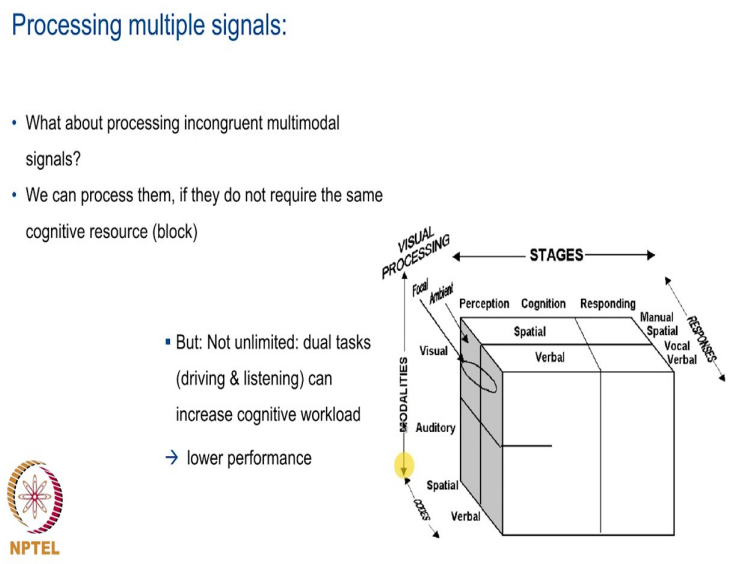


for example the different modalities, the visual one and the auditory one but of course, that can be easily extended by other modalities such as haptics.

For the visual one, we have the specialty

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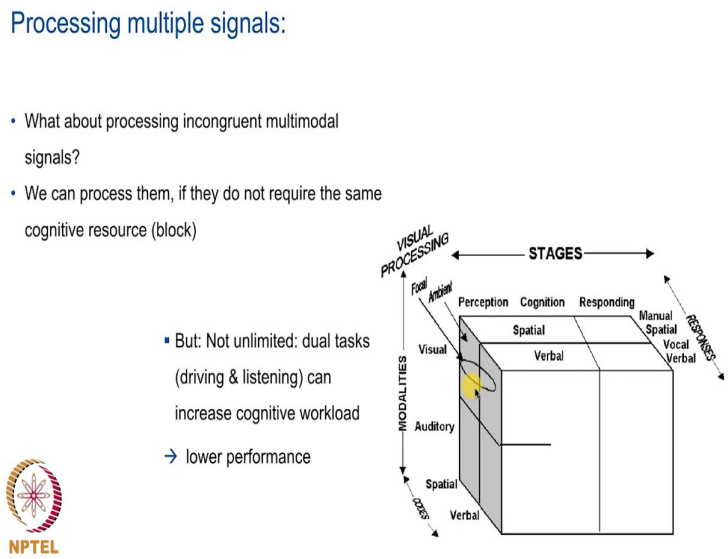


namely focal versus ambient information. Then we have different stages

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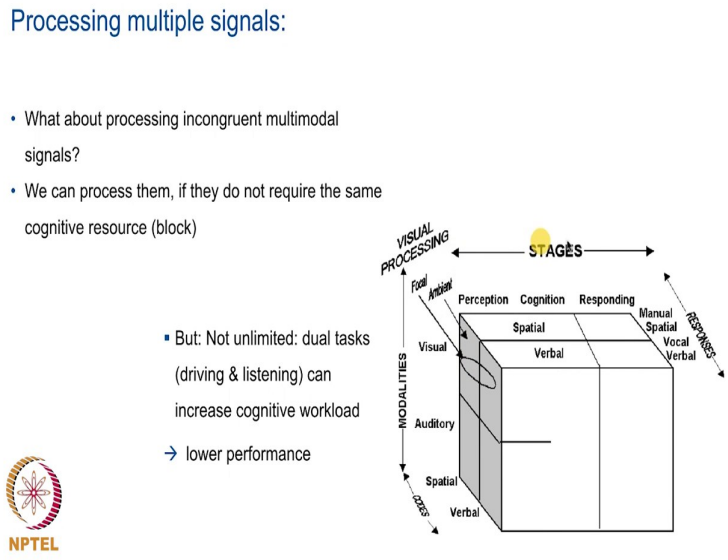


of processing, for example, the perception of the information, the cognition and the response generation, so our own actions. And as you can see there are some cubes

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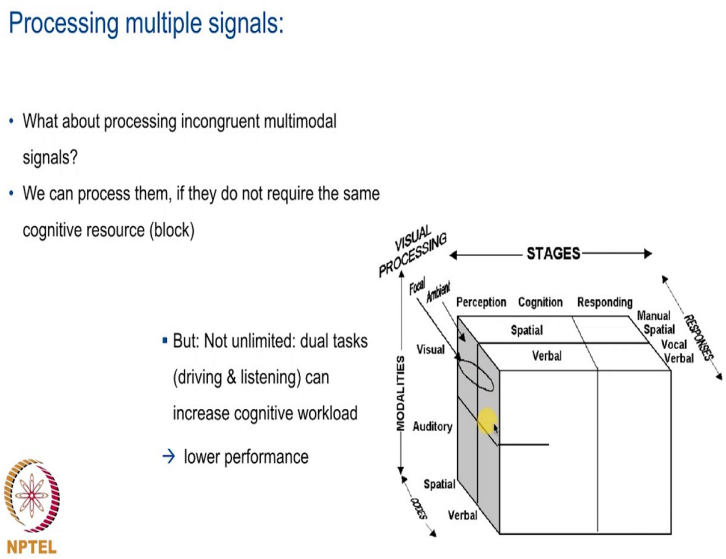


within the cube which illustrate the different cognitive resources.

But of course these are not strictly or strongly separated from each other. Some are more, some are less. The whole idea is if we have to deal with different tasks, with multiple tasks during the same time, we might use or actually do this successfully by using the different cognitive resources that we have.

So for example, if we would read a text,

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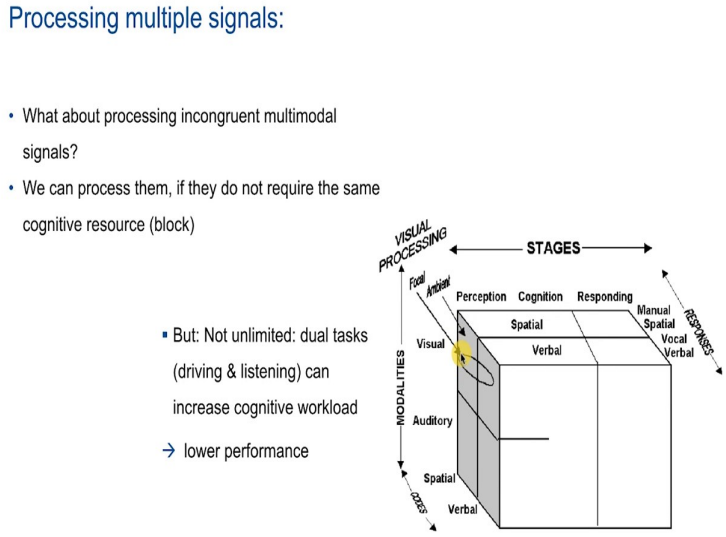


we might still walk during the same

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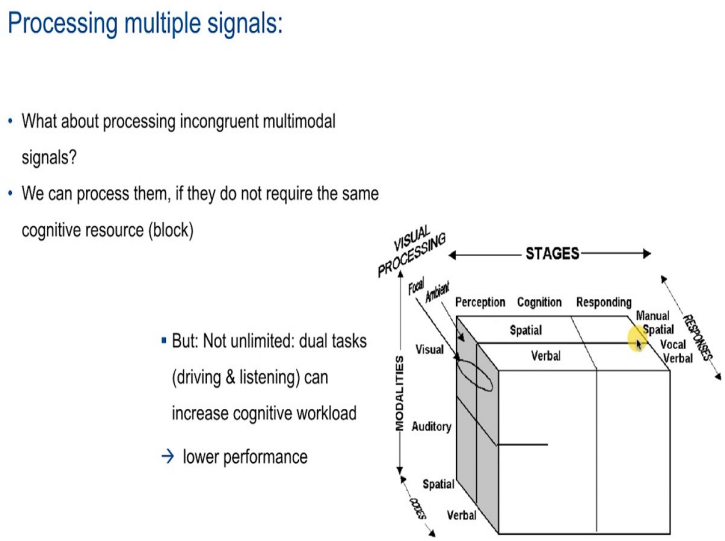


time because these requires different cognitive resources which do not conflict.

So if there are conflicting tasks because they share the same or similar cognitive resources you might actually result in lower performance, this means higher error rate or if we really try to do both tasks faithfully we might be stressed a little bit, slower than compared to doing these two tasks one after another.

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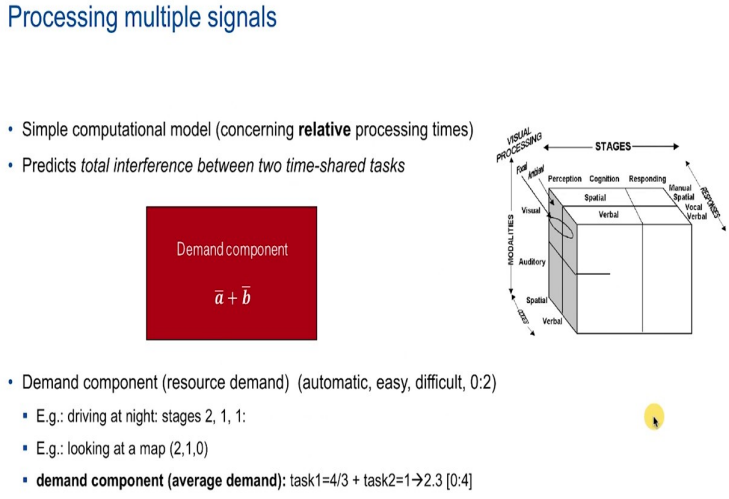


They are actually a number of computational models trying to predict this kind of behavior. And here is a really simple one which is quite old but illustrates nicely the whole idea of different cognitive resources.

So the aim of this small model or simple model is to estimate relative durations. This means, is the dual task having two tasks now taking longer than other dual tasks or taking longer than doing the two tasks individually, one after another? Let us go through this model, one by one.

So the model predicts the total interference

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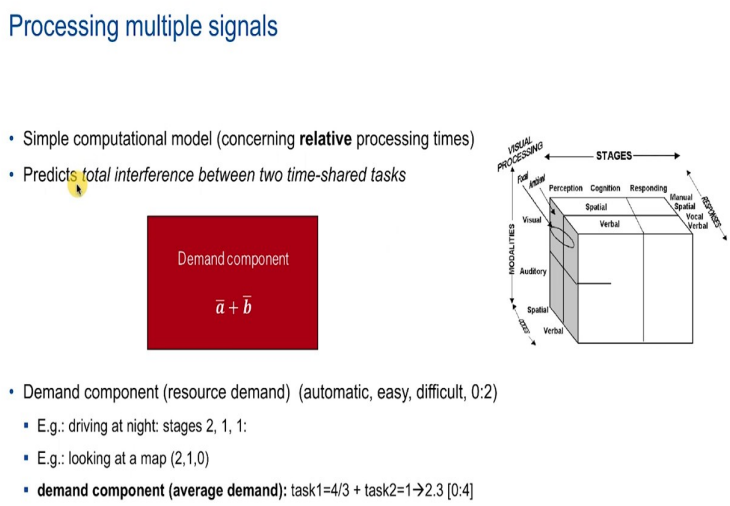


between two tasks which are shared in the time. First we try to calculate a demand component. This is just the sum of the average, the cognitive demand that these two tasks would have. So let us assume we have two tasks.

One is driving at night and one is looking at map at the same time. Here we just associate the task component or the task demand according to the three stages that we have, perception,

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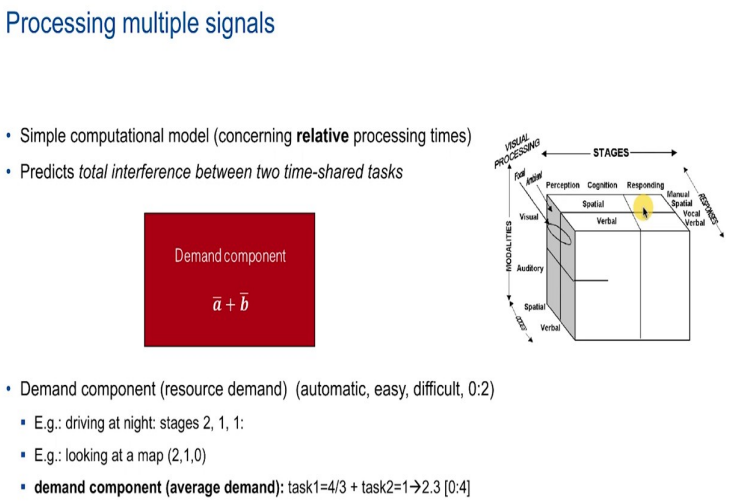


cognition, responding. We just assign values from 0 for automatic to 2 for difficult to these two stages.

For example driving at night could be rather difficult from a perceptional point of view so this would be 2. And cognition and responding so the processing and the driving itself might be not totally automatic but easy so there would be two 1s.

Looking at the map at the same time would again be quite difficult from perception point of view but the stages, cognition would be easy and responding would be 0 because there is actually nothing to do except for holding the map for short while.

So if we now compute the demand component we just average these 3 values and add them up of the two tasks. This would result in the number 2 dot 3 if we have values from 0 to 4.

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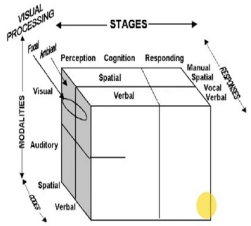
Processing multiple signals:

- Demand component plus
- Multiple resource conflict component (degree to which overlapping resources are required) (sharing resources on the 4 dimensions)
  - Use a conflict matrix with penalties




The second step now is to calculate which conflicting resources are used by the two tasks.

Here we use a kind of conflict matrix.

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Processing multiple signals:

resource conflict component

Task A Resources

| | | Perceptual | | | | Cognitive | | Response | |
|---|---|---|---|---|---|---|---|---|---|
| | | VS | VV | AS | AV | CS | CV | RS | RV |
| | VS | 0.8 | 0.6 | 0.6 | 0.4 | 0.7 | 0.5 | 0.4 | 0.2 |
| | VV | | 0.8 | 0.4 | 0.6 | 0.5 | 0.7 | 0.2 | 0.4 |
| | AS | | | 0.8 | 0.4 | 0.7 | 0.5 | 0.4 | 0.2 |
| Task B | AV | | | **0** | .8 | 0**.5** | 0**.7** | 0**.2** | 0**.4** |
| Resources | CS | | | 0 | | .8 | 0.6 | 0.6 | 0.4 |
| | CV | | | | | | 0.8 | 0.4 | 0.6 |
| | RS | | | | | | | 0.8 | 0.6 |
| | RV | | | | | | | 0.6 | 1.0 |

VS: visual-spatial; AS: auditory-spatial
VV: visual-verbal; AV: auditory-verbal

So this is actually built up from empiricism, so we have empirical results from the laboratory where we found out that these kind of values.

And if you have a look here, these are the tasks 1, all different cognitive resources that we might have, sorted by the different stages. So this would be visual spatial for example, this would be auditory spatial.

We have the same components for the second task, task B. The whole idea is now just to find out if our two tasks that we are currently trying to model, share the same resources or resources that result in a conflict if they are both active.

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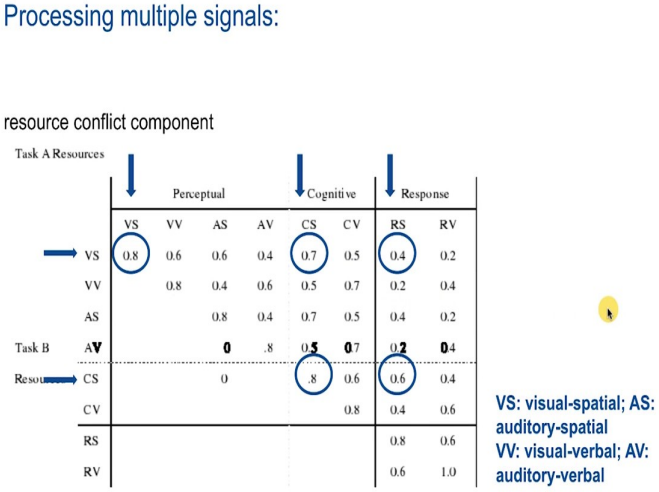


For example driving at night and looking at a map at the same time definitely shares the same cognitive resource of visual spatial perception.

But visual spatial perception of the task B also conflicts with a response. So we just, use these kind of values that we have and add them up.

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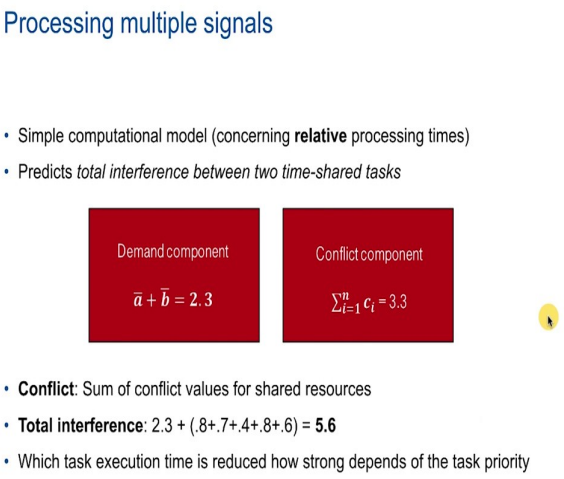


So the final interference between the two tasks is the already calculated demand component of the 2.3 and the sum of these conflicts that we identified from the matrix.

This would be then resulting in sum of 5.6. This is an arbitrary number and gives us relative information on the tempo and the duration of these two tasks that can be completed.

These numbers are used to predict and model durations of dual tasks compared to other dual tasks and compared to single task. So this means doing this single task individually.

So as you can see these kind of dual task paradigm tells us that we can indeed facilitate our task completion although we have several tasks which demand certain cognitive resources but we might end up with some conflicts that means or result in us doing longer, using a longer time to complete the task or doing more errors.

Nevertheless it is a nice, easy and simple model from empirical results that tells us or explains how we can actually do several tasks at the same time without failing completely.