

## **Together towards tomorrow: Sensory prosthetic devices**

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### **Abstract**

A sensory prosthetic device (SPD) is any tool that enables a person to use their senses to engage with the world in ways that would otherwise not be possible. An example of an SPD for the tactile sense is the white cane, which makes it possible for a person who is blind to extend their reach beyond the physical confines of their body. The white cane is therefore regarded as an augmentative SPD. Other illustrations of augmentative SPDs are: spectacles, contact lens, hearing aids and wireless FM systems. An alternative SPD is a tool that empowers the person to substitute the missing sense ability with a new, different skill. These include: the speech-generating device (SGD), the cochlear implant, the powered exoskeleton, and the bionic eye. This paper explores the educational role of augmentative and alternative SPDs for children with sensory disabilities, particularly how SPDs will impact on a child's ability to participate in the world, both now and into the future.

### **Introduction**

Thanks for the introduction and welcome to this the final session for today. No doubt you're all feeling a bit tired after attending so many papers and workshops. It's been a long day. I therefore thought it might be a good idea to start with a little bit of light relief. Are you ready? For those with vision impairment I'm going to show two slides with photographs. I'll show them and then provide an audio description. I'll also provide an audio description for all slides in my Power Point presentation.

The first slide has two photographs. It's a before and after set. The before is a photo of two small fluffy dogs in an empty bathtub happily smiling at the camera. The after shot is a photo of the same two dogs. Now they are soaking wet and bedraggled. Their smiles have disappeared altogether.

The next slide is of a toilet in a very confined space, so confined in fact that the inwardly opening toilet door has a cut out in the shape of the toilet bowl to enable clear passage. It's amazing how ingenious people can be at problem solving, and that's the focus of my talk this afternoon – the types of problem solving that have occurred for people with sensory disabilities.

The title of my paper is “Together towards tomorrow: Sensory prosthetic devices”. I chose the together towards tomorrow part of the title to go with the conference theme with the focus of the talk on the sensory prosthetic devices. The photo on this slide is of an athletic looking young man climbing a 90-degree cliff face. He has a climbing rope, a harness, and two prosthetic legs made of metal tubes with metal stubs for feet. This photo really drives home the message that it’s the prosthetic legs that are enabling the man to do the activity, something that would be totally impossible if he didn’t have them.

My plan for this paper is to begin by defining the term sensory prosthetic device (SPD). I’ll then consider two different types of SPDs (augmentative and alternative), explore some examples, and then examine possible implications SPDs may have for education. Oh and along the way I’ll offer a theoretical context. In this slide I’ve included a photograph of a young white female model. She’s very stylish in a short white dress, sitting with her legs crossed to reveal high-heeled white shoes and a high-tech design metal prosthetic leg. Here the prosthetic has become a fashion item.

As I said I plan to begin by defining the term SPD. For this definition I want to start with the word sensory. Sensory means pertaining to the senses and I define a sense as any faculty that accesses stimulation from inside or outside the body so this includes movement as well as the traditional senses of vision and hearing.

A sensory prosthetic device therefore is any tool that enables a person to use their senses to engage with the world in ways that would otherwise be impossible. The photo accompanying this slide is of the same model this time wearing a different prosthetic leg – one to complement her black futuristic mini dress and her black high-heeled shoes.

As I said earlier there are two different types of SPDs. They are: Augmentative SPDs. These are devices that supplement the sense ability. The second type is Alternative SPDs. These are devices that offer a substitute ability of some kind. The slide includes two visuals: the first is the cover of *Machine Design* with a feature article entitled: “*Reach out and feel something – haptic technology*”. The second is the cover of a book entitled: “*Neural prosthetics for restoration of sensory and motor function*”.

The senses that enable us to access stimulation from inside the body are called the senses of interoception (the movement related senses). These are proprioceptive, vestibular, and any other sense receptor stimulated from inside the body. The senses of interoception enable us to move around. There’s been a lot of interest in the media lately regarding these prosthetics. Here are a few examples:

This slide comprises six photographs that redefine capability regarding interoception – going clockwise from top left

1. The cover of design news has a feature article on bionic engineering and the power foot.
2. Christine Wolf sets a new world record in the long jump with a prosthetic leg.
3. Trent Milton a snowboarder uses a prosthetic leg to compete in the Sochi winter paralympics.
4. Michelle Errichiello becomes the 100 m world record holder using her prosthetic leg.
5. Oscar Pistorius with two prosthetic legs competes against able-bodied athletes during the Summer Olympics in London in 2012.
6. Ryley Batt in the wheel chair rugby.

The senses that enable us to access stimulation from outside the body are called the senses of exteroception. These are vision, hearing, touch, taste, and smell. There's also been a lot of interest in prosthetics in these areas.

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Other examples of augmentative SPDs are: spectacles and contact lens to supplement vision, and hearing aids and wireless FM systems to supplement hearing.

Then we have examples of alternative SPDs. An alternative SPD is a tool that empowers the person to substitute the missing sense ability with a new, different skill. A good example of an alternative SPD is the speech-generating device (SGD). It comes in many forms but often consists of an electronic communication board with symbols that the person activates to produce artificial speech.

Other examples of alternative SPDs are the cochlear implant, the powered exoskeleton, and the bionic eye, which we've heard about at this conference when Dr Lauren Ayton presented a keynote detailing the research being done in this area here in Melbourne.

So now I just want to check that everyone has a clear idea of what we're talking about. To recap: We're talking about SPDs. They are tools that enable a person to use their senses to engage with the world in ways that would otherwise be impossible. There are two types of SPDs: Augmentative SPDs

that supplement the sense ability, for example spectacles help rectify vision problems; and Alternative SPDs. These are SPDs that substitute a missing ability with a new skill, for example the cochlear implant.

Now I want you to chat with your neighbour about what SPDs mean for the education of children with sensory disabilities.

At the start of this paper I said I'd provide a theoretical context for the discussion. Well here is it. Basically it's a summary of the major theories used to explain how we make sense of the world, with an extra one thrown in for good measure.

The first is called the bottom up theory, which makes the assumption that the information flows from the sense organ to the brain.

The second theory is called the top down theory. It makes the opposite assumption, namely that the information goes from the brain to the sense organ. The information in the brain enables the person to determine what is being sensed.

The third theory the filling in theory is based on the assumption that both the bottom up and top down theories are correct, and this allows the person to be able to make conjectures regarding missing information.

The fourth theory predictive coding makes the assumption that the brain is an engine of prediction, so that making sense of the world is largely anticipatory. Because of predictive coding making sense of the world is an affective experience.

The fifth theory material engagement theory makes the assumption that our brains employ cognitive sensory prosthetic devices to engage with the world and these enable us to make sense of the world in new ways that would not be possible with out them.

The sixth theory is my own theory. I call it the unified theory. This theory incorporates all the sensory processing insights from the earlier theories and adds another layer, chronoception, our sense of time. Our sense of time is a meta-sense because it enables us to use our senses in combination.

## **Conclusion**

There are important implications for education regarding social inclusion and academic expectations. SPDs will increase children with sensory disabilities': accessibility; educational opportunities; highest potential; independence