

## 4.1

The goal of psychophysical experiments is to understand the link between differences in the physical characteristics of stimulations delivered to people and their perception of these stimulations. Psychophysical experiments enable to predict behavior in similar situations and to formulate hypotheses about the involved sensory mechanisms.

## 4.2

The just noticeable difference is the minimum difference in one physical characteristics of a signal (e.g: amplitude, frequency...) that is consistently (usually 75% of the time) perceived by humans?

## 4.3

One such experiment could involve a PHANTOM type device and two springs in virtual reality. In each trial, the user would be able to press on both spring, which can have different stiffness constants  $k$ . The Phantom device will use the position of the finger to output the force that relates to the  $k$  constant of each spring.

- Psychophysical method. A good option is to use an adaptive method (see video). One of the springs, which randomly change from trial to trial, will always have a reference  $k$  constant. The question to participants will be: which spring is stiffer? The  $k$  of the other spring (comparison spring) will change depending on the previous answers. Within 20-30 trials, the comparison  $k$  should converge to the JND.
- Why use an adaptive method? It is faster than the constant stimuli method if the experimenter is only interested in the JND. In addition, the PHANTOM is a very precise device with a large range of force feedback and there is no risk for the requested force values to go beyond its capabilities.

If springs are visually represented, attention should be paid to the influence of multisensory integration and possible pseudo-haptic effects (see Lecuyer 2009). It is also possible that the type of handle plays a role (e.g: pressing vs. grasping). The experimenter should make sure that participant can properly focus on the task.

However, since two stimulations are compared at each trial and participants have to respond, there is no risk of criterion bias (when participant are not sure whether they felt a difference or just imagined it)

**Which device?** As mentionned, the PHANTOM series are a good choice but the experiment can also take place with other devices:

- Omega series are also a good choice since the needed workspace is small
- NOVINT Falcon is also usable because rendering stiffness does not require too much force resolution.
- Even a much simpler DIY device as the 'Woodenhaptic' is probably enough to make a reasonable estimation (only 1D is needed for the spring)
- In general, all devices that can render force during a push are suitable.

- Limitations are mainly related to the attentional focus of participants and to the resolution of the device. A device that does not accurately record position and/or render force with a few percents error will bias the results.

Reference:

*Lécuyer, A. (2009). Simulating haptic feedback using vision: A survey of research and applications of pseudo-haptic feedback. Presence: Teleoperators and Virtual Environments, 18(1), 39-53. [LINK](#)*