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Compatibility of gain-control and power law representations-a János Aczél connection

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Detection probabilities in sensory psychology are sometimes analyzed in terms of a gain control representation, such as P(x,y)=F[(u(x)-g(y))/h(x)]. Here, x and y are positive real numbers denoting physical energies, P(x,y) is the probability of detecting stimulus x over background y, and u, g, h and F are real valued, continuous, strictly increasing functions. In some situations (e.g., in psychophysics), the researchers are more interested in the functions u, g. and h, than in the function F. In such cases, they investigate the detection phenomenon by estimating empirically the value y such that P(x,y) = , for some values of , and in for many values of x. In other words, they study empirically the function satisfying y. a reasonable model to consider for the function is offered by the power law representation x in which and K are nonconstant functions of p. In this paper we investigate the consistency of these gain control and power law representations. The main result is that, under some background conditions, if the gain control and the power law representations jointly hold, then the detection probability P takes necessarily the form P(x,y) = (see Theorem 2.1). The form of the function F is arbitrary.