Perineural invasion (PNI) is the phenotype in which tumor cells surround and enter nerves. PNI is associated with recurrence and metastasis of head and neck cancer (HNC). Recent studies have demonstrated a mechanism by which HNC can induce neurite outgrowth towards itself: when stimulated by the neuropeptide galanin (Gal), the tumor secretes Gal, which leads to neurite outgrowth towards the tumor. In order to gain an understanding of the distances, spatial arrangements, and temporal sequences of these events, we must understand the parameters that control them. We developed a hybrid model for PNI: we model Gal diffusion with a PDE and neurite outgrowth with an agent-based model (ABM). The ABM incorporates several biological features of neurite outgrowth; the model captures qualitative features of PNI. We performed a sensitivity analysis to demonstrate that uncertainty in biological parameter values can have a significant impact on the mechanistic model outputs. Our sensitivity analyses identify biologically relevant parameters that need additional experimental study: our results indicate that further biological research is needed to refine our understanding of the spatiotemporal dynamics of PNI. (Received August 16, 2018)