The "capping" or coating of nanosilver (nanoAg) extends its potency by limiting its oxidation and aggregation and stabilizing its size and shape. The ability of such coated nanoAg to alter the permeability and activate oxidative stress pathways in rat brain endothelial cells (RBEC4) was examined in the present study. The aggregate size and zeta potential of nanoAg with different sizes (10 and 75 nm) and coatings (PVP and citrate) were measured in cell culture media. Results indicated that both PVP-coated nanoAg were less electronegative than their citrate-coated counterparts over all exposure times, but only the PVP-coated 10 nm particles retained their initial electronegativity over all exposure times. In addition, only the PVP-coated particles retained their initial sizes throughout the 3 h measurement. PVP-coated 10 nm nanoAg selectively altered the permeability of RBEC4 monolayers within a 15 min exposure, although high resolution microscopy indicated that all coated nanoAg distributed throughout the cell's cytoplasm within the 3 h exposure. Reporter genes for AP-1 and NRF2/ARE, transfected into RBEC4, were selectively stimulated by the PVP-coated 10 nm nanoAg. Global gene arrays indicated that only PVP-coated nanoAg significantly altered gene expressions in the RBEC4, and those altered by 10 nm PVP-coated nanoAg were qualitatively similar but quantitatively much higher than those of its 75 nm counterpart. IPA and DAVID analyses indicated that the altered pathways affected by both PVP-coated nanoAg were primarily associated with a NRF2-mediated oxidative stress response, endocytosis, and bioenergetics. Together, these data suggest that the physicochemical features of surface coating aggregate size and surface charge contribute to capped nanoAg's permeability and oxidative stress responses in RBEC4.