Supramolecular polymers are used in many applications such as adhesives, coatings, cosmetics, and printing. Characterizing the dynamics of such polymers is essential for tailoring user defined properties in products and applications. We present both linear and nonlinear rheological results for a model system of pure poly(n-butyl acrylate), PnBA, homopolymer and four PnBA− poly(acrylic acid), PnBA−PAA, copolymers with different number of AA side groups. The copolymers are synthesized via hydrolysis of the pure PnBA homopolymer. Therefore, all polymers studied have the same backbone length. The number of AA side groups (hydrogen-bonding groups) after hydrolysis is determined from NMR measurements. We show that using the theoretical dependency of modulus and reptation time on the packing length, we can account for the changes in linear viscoelasticity due to transformation of nBA side groups to AA along the backbone. Assuming superposition holds and subtracting out the linear chain rheology from LVE, the hydrogen bonding contribution to LVE is exposed. Hydrogen bonding affects linear viscoelasticity at frequencies below the inverse reptation time. More specifically, the presence of hydrogen bonds causes $G'$ and $G''$ as a function of frequency to shift to a power law scaling of 0.5. Furthermore, the magnitude of $G'$ and $G''$ scales linearly with the number of hydrogen-bonding groups. The nonlinear extensional rheology shows extreme strain hardening. The magnitude of extensional stress has a strongly nonlinear dependence on the number of hydrogenbonding groups. These results are aimed at uncovering the molecular influence of hydrogen bonding on linear and nonlinear rheology to aid future molecular synthesis and model development.