Coulomb Pseudopotential in metals: When multiple mistakes cancel out

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I will explore the effect of Coulomb repulsion on the phonon-mediated Cooper instability in the electron gas using a numeric approach that is controllably accurate at small to moderate values of the Coulomb parameter, $\lesssim 2$. The necessity of breaking the net result into two distinctively different effects, the reduction of the Fermi-liquid renormalization factor and the change of the effective low-energy coupling, makes the existing pseudopotential approach without any merit. Moreover, the effective coupling is a non-monotonic function of r_s with an extremum at $r_s \approx 0.75$. Within the random-phase approximation, Coulomb interaction eventually starts to enhance the effective pairing at $r_s > 2$, and the suppression of the critical temperature is entirely due to the renormalized Fermi-liquid properties. The onset of the enhancement is, however, sensitive to the approximation used for incorporating vertex corrections. Our results call for radical reconsideration of the widely accepted picture that the effect of Coulomb interactions reduces to a (weak) repulsive pseudopotential.