Time Dilation Paradox

Consider two reference frames $S$ and $S'$ in relative motion. An observer in $S$ determines that time in $S'$ is slowed, whereas an observer in $S'$ determines that time in $S$ is slowed. How can both observers be right?

Clocks 1 and 2 are synchronized in $S$ for all times.
Clocks 1 and 3 are synchronized at $t = 0$.

View from frame $S$:
Proper distance between clocks 1 and 2: $\ell_0$.
Reading of clock 2 when clock 3 arrives there: $t = \ell_0/v$.
Time elapsed in $S'$: $t' = (\ell_0/v)\sqrt{1 - v^2/c^2}$.

View from frame $S'$:
Distance between clocks 1 and 2: $\ell' = \ell_0\sqrt{1 - v^2/c^2}$.
Reading of clock 3 when it reaches clock 2: $t' = \ell'/v = (\ell_0/v)\sqrt{1 - v^2/c^2}$.
Time elapsed in $S$: $\Delta t = t'\sqrt{1 - v^2/c^2} = (\ell_0/v)(1 - v^2/c^2)$.
Initial reading of clock 2 as viewed from $S'$: $t_i = \ell_0 v/c^2$.
Final reading of clock 2: $t_i + \Delta t = \ell_0/v$. 