An alternative method for $n_\sigma = 1$:

(proposed by Rechenberg; see e.g. (Ostermeier 1992)).

$$
\begin{aligned}
I &= I\!R^n \times I\!R_+ \\
m'_{\{\alpha\}}(\vec{x}, \sigma) &= (\vec{x}', \sigma')
\end{aligned}
$$

$$
\boxed{
\begin{aligned}
\sigma' &= \sigma \cdot u \\
x'_i &= x_i + \frac{\sigma'}{\sqrt{n}} \cdot N_i(0,1)
\end{aligned}
}
$$

- $u \in \{1, \alpha, 1/\alpha\}$ with equal probability for each of the three outcomes $\Rightarrow$
  - **One-third of the offspring tries larger step-sizes,**
  - **one-third of the offspring tries smaller step-sizes, and**
  - **one-third of the offspring keeps step-sizes constant.**
- Normally, $\alpha = 1.5$ is used **(Ostermeier, 1992).**
- Terminology: *Mutational stepsize control* **(Rechenberg).**
- Extension proposed by **(Ostermeier 1992):** *Momentum adaptation.*
  (Allow for an adaptation of expected values *different from zero* for the normally distributed random numbers).