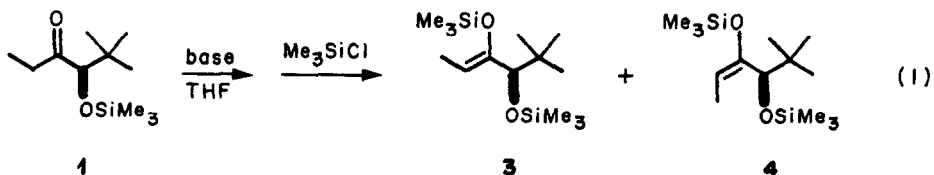
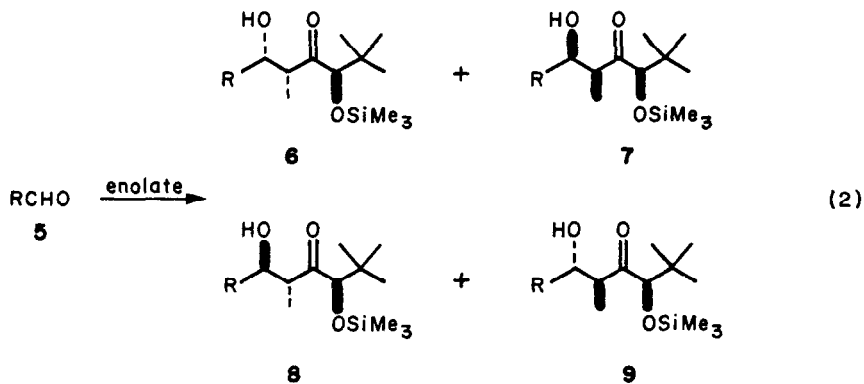


provided a 96:4 mixture of *Z* and *E* enolsilanes **3** and **4** (eq 1).



Treatment of **1** with bromomagnesium isopropylcyclohexylamide in THF at $-30\text{ }^{\circ}\text{C}$, followed by silylation with TMSCl gave the *Z* and *E* enolsilanes in a ratio of 9:91 (eq 1).¹⁰ The di-*n*-butylboron enolate of **1**, presumably *Z*, was prepared by reaction of the ketone with di-*n*-butylboron triflate and diethylisopropylamine in methylene chloride.¹¹

Aldol reactions of the lithium and boron enolates of **1** were carried out by literature procedures.^{4,7} The magnesium enolate reactions were carried out in THF (0.3 M enolate, 0.33 M aldehyde) at $-78\text{ }^{\circ}\text{C}$ for 20 min; reaction was quenched by the addition of aqueous sodium bicarbonate at $-78\text{ }^{\circ}\text{C}$. The aldehydes employed were isobutyraldehyde (**5a**) and benzaldehyde (**5b**). The four diastereomeric aldols that may be produced from **1** and an aldehyde are shown in eq 2. Results



a: R = *i*-Pr, b: R = Ph

of the investigation are summarized in Table 1. Stereostructures of the four aldols in the benzaldehyde series (**6b-9b**) were determined in the following manner. The structure of **6b**, the major isomer obtained in the lithium enolate reactions has been assigned previously.⁴ On the basis of Masamune's work with the related ketone **2**,⁷ we have assigned the major isomer obtained in the boron

Table 1
Stereochemistry of Reaction of Ketone 1 with Aldehydes (Eq 2)

Enolate	Config. Z:E	Aldehyde	Product Composition				Yield, %
			6	7	8	9	
Lithium	96:4	5a	88	12	0	0	70
Lithium	96:4	5b	84	16	0	0	75
Magnesium	9:91	5a	11	11	64	14	72
Magnesium	9:91	5b	10	10	70	10	70
Boron	a	5a	10	90	0	0	70
Boron	a	5b	7	93	0	0	70

(a) The enolborinate geometry was not determined, but is presumed to be largely Z on the basis of prior work (ref 7, 10).

enolate reaction structure 7. The major isomer obtained in the magnesium enolate reaction was determined to have structure **8b** by single crystal x-ray analysis of the corresponding dihydroxy ketone, mp 85-86 °C.

It is interesting that three of the four possible aldols can be selected as the major product of the reaction of 1 by a simple choice of cation. As has previously been pointed out,¹² the stereochemistry observed in the aldol reactions of 1-lithium enolate may be explained by invoking the chelated enolate, which reacts on its less hindered re face (Figure 1a), while that seen in the aldol reactions of 1-boron enolate seem to result from reaction on the unchelated Z boron enolate, which reacts preferentially on its si face (Figure 1b).

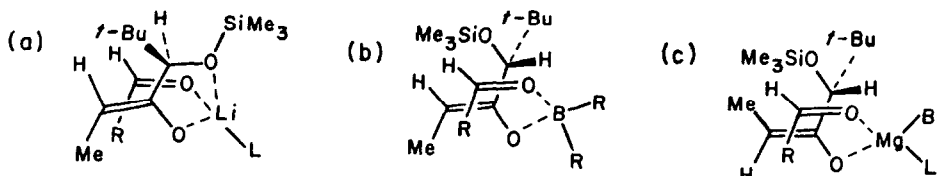


Figure 1: (a) Approach of an aldehyde to the re face of the chelated Z lithium enolate of ketone 1. (b) Approach of an aldehyde to the si face of the unchelated Z boron enolate of ketone 1. (c) Approach of an aldehyde to the si face of the unchelated E magnesium enolate of ketone 1.

The magnesium enolate of 1 is "boron-like" in its diastereofacial preference; reaction occurs on its si face. However, since the major enolate has the E configuration, the predominant product is 8, rather than 7. Thus, the magnesium must not be chelated by the trimethylsilyloxy group during the aldol process (Figure 1c).

ACKNOWLEDGEMENT: This work was supported by a research grant from the United States Public Health Service (AI15027).

References and Notes

1. For part 34, see: Heathcock, C. H.; Uehling, D. E. J. Org. Chem., in press.
2. Current address: ICSN, CNRS, 91190 Gif Sur Yvette, France.
3. Heathcock, C. H.; Pirrung, M. C.; Buse, C. T.; Hagen, J. P.; Young, S. D.; Sohn, J. E. J. Am. Chem. Soc., 1979, **101**, 7077.
4. Heathcock, C. H.; Pirrung, M. C.; Lampe, J.; Buse, C. T.; Young, S. D. J. Org. Chem., 1981, **46**, 2290.
5. Heathcock, C. H.; Young, S. D.; Hagen, J. P.; Pilli, R.; Badertscher, U. J. Org. Chem., 1985, **50**, 2095.
6. Masamune, S.; Ali, S. A.; Snitman, D. L.; Garvey, D. S. Angew. Chem. Int. Ed. Engl., 1980, **19**, 557.
7. Masamune, S.; Choy, W.; Kerdesky, F. A. J.; Imperiali, B. J. Am. Chem. Soc., 1981, **103**, 1566.
8. Masamune, S.; Hirama, M.; Mori, S.; Ali, S. A.; Garvey, D. S. J. Am. Chem. Soc., 1981, **103**, 1568.
9. See also: Masamune, S.; Choy, W.; Petersen, J. S.; Sita, L. R. Angew. Chem. Int. Ed. Engl., 1985, **24**, 1.
10. α -Alkoxy ketones show a remarkable tendency toward formation of *E* enolates upon reaction with bromomagnesium isopropylcyclohexylamide. Thus, the trimethylsilyl ether of 2-hydroxy-2-methyl-3-pentanone is converted into a 67:33 mixture of *E* and *Z* enolsilanes by the same procedure. A full investigation of this phenomenon is underway.
11. (a) Fenzl, W.; Köster, R. Liebigs Ann. Chem., 1975, 1322. (b) Masamune, S.; Mori, S.; Van Horn, D.; Brooks, D. W. Tetrahedron Lett., 1979, 1665. (c) Evans, D. A.; Vogel, E.; Nelson, J. V. J. Am. Chem. Soc., 1979, **101**, 6120. (d) Evans, D. A.; Nelson, J. V.; Vogel, E.; Taber, T. R. J. Am. Chem. Soc., 1981, **103**, 3099.
12. (a) Heathcock, C. H. "Asymmetric Reactions and Processes in Chemistry"; Eliel, E. L.; Otsuka, S., Eds.; American Chemical Society: Washington, D.C., 1982. (b) Heathcock, C. H. "Asymmetric Synthesis, Volume 3"; Morrison, J. D., Ed.; Academic Press, Inc.: New York, 1984.

(Received in USA 1 August 1985)