H, aliph CH_2), 2.68 (t, 12 H, CH_2N), 3.30–3.90 (m, 23 H, CH_2O).

Acknowledgment. We thank the National Institutes of Health for grants GM 33940 (physical studies) and GM 36262 (syntheses) which supported this work.

Supplementary Material Available: 60-MHz ^1H NMR spectra of compounds A, C, D, 1, and 2; infrared spectra for compounds C, D, and 1; and 100-MHz ^{13}C NMR spectra for compound 1 (9 pages). Ordering information is given on any current masthead page.

Reactions and Diastereoselectivity of N^2-Arylsulfonyl Amidine Anions

Philip Magnus*[,1] and John Moursounidis

Department of Chemistry, Indiana University, Bloomington, Indiana 47405

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Cyclic N^1-alkyl-N^2-sulfonyl amidine anions undergo stereoselective aldol reactions to give the syn diastereoisomer as the major product. The ratio of syn to anti aldol products decreases as the size of the N^1-alkyl increases. This is interpreted as a change in the transition state from an open-aldol to a closed-Zimmerman–Traxler-type transition state.

Compared to the extensive investigations of the alkylation and aldol chemistry of cyclic ketones, cyclic amides (lactams) have received considerably less attention.[2] Part of our alkaloid research program required alkylation of the amide enolate (endo-*E* enolate) **2** derived from the tetracyclic amide **1**.[3] While we could not successfully alkylate **1**, the derived thioamide **3** underwent thio-Claisen rearrangement, as described by Takano[4] to give **4**. Thioamides exhibit increase diastereoselectivity in the aldol reaction compared to amides. For example, *N*-methylthiopyrrolidone **5** gave the syn and anti aldol products **5a** and **5b**, respectively, in a 19:81 ratio, whereas *N*-methylpyrrolidone **6** gave the syn and anti aldol products **6a** and **6b**, respectively, in a 1:1 ratio (Scheme I).[5]

If the oxygen atom of an amide is replaced by a functional group that could exert either a steric or electronic effect, or a combination of both, changes in the diastereoselectivity might result. With this in mind we have examined some reactions of N^1-alkyl-N^2-*p*-tolylsulfonyl amidine anions (Scheme II). It is somewhat surprising that the chemistry of these anions has not been previously explored.

For Scheme II, *N*-Ts geometry in **7** is *E* (X-ray crystallographic structural data on aldol adducts **51**, **52**, and **65**). The *N*-lithio derivative **8** should undergo C-alkylation to give **9**. The alkyl group R in **9** should assume an axial conformation, at least for a six-membered ring ($A^{1,3}$ strain).[6] It is difficult to predict the diastereoselectivity of the reaction between the lithio derivative **8** and an aldehyde. On the one hand the prior literature shows that cyclic ketone enolates react with aldehydes under kinetic control (no demonstrable equilibration) to give the anti aldol product as the major diastereoisomer.[2] As mentioned above, the same situation is true for lactam enolates. A *Zimmerman–Traxler*-type transition state for an *E* enolate (cyclic amidine) predicts the anti diastereoisomer, whereas the so-called open transition state for an *E* enolate leads to the syn diastereomer.[7] The *N*-lithio derivative **8**, in a conformation where the N^1-alkyl group and N^2-Ts group are *Z* (syn), in a *Zimmerman–Traxler* transition state **11**, leads to the anti diastereoisomer **12**, and the rotamer **13** leads to the syn diastereoisomer **14** (Scheme III).

An open transition state such as shown in Scheme IV leads to a reversal of the diastereoisomers for a particular orientation of the aldehyde. This simple analysis is severely complicated by the various steric interactions of the NTs group with the NR group and the R group in the aldehyde. These various manifestations of $A^{1,3}$ steric strain will no doubt play important roles in transition states such as **11**/**13** (NTs, NR $A^{1,3}$ strain) and **15** (NTs, R $A^{1,3}$ strain), but before the fact it is difficult to make significant predictions regarding the preferred, if any, diastereoselectivity. Although two reasonable predictions are possible, the newly formed carbon–carbon bond in either *syn*-**10** or *anti*-**10** should be axial (for a six-membered ring) and remain axial **17**. Conformational relaxation to the equatorial conformer **18** should be prevented by the $A^{1,3}$ strain that develops when, and if, the stereochemical relationship between the NR and NTs functionality is *E*. This will depend upon the size of R, and as a consequence, there should be a trend in the extent of diastereoselectivity as a function of the bulk of R. There should also be a change in the diastereoselectivity as the size of the Ts group is altered (trisyl, for example). We have not examined this possibility.

The synthesis of N^1,N^1-dialkyl-N^2-*p*-tolylsulfonyl amidines **7** was accomplished in a straightforward manner, using a reaction described in 1960 by King.[8] Treatment

(1) Address correspondence to this author at The Department of Chemistry and Biochemistry, The University of Texas at Austin, Austin, TX 78712.

(2) Evans, D. A. Stereoselective Alkylation Reactions of Chiral Metal Enolates In *Asymmetric Synthesis*: Morrison, J. D., Ed.; Academic Press Inc.: 1984; Vol. 3, p 1. Heathcock, C. H. The Aldol Addition Reaction In Morrison, J. D., Ed.; *Asymmetric Synthesis*; Academic Press Inc.: 1984; Vol. 3, p 111.

(3) Magnus, P.; Ladlow, M.; Kim, C. S.; Boniface, P. *Heterocycles* **1989**, *28*, 951. Magnus, P.; Ladlow, M.; Elliott, J.; Kim, C. S. *J. Chem. Soc., Chem. Commun.* **1989**, 518.

(4) Takano, S.; Yonaga, M.; Ogasawara, K. *J. Chem. Soc., Chem. Commun.* **1981**, 1153. Takano, S.; Hirama, M.; Araki, T. K.; Ogasawara, K. *J. Am. Chem. Soc.* **1976**, *98*, 7084.

(5) Tamura, Y.; Harada, T.; Nishi, S.; Mizutani, M.; Hioki, T.; Yoshida, Z. *J. Am. Chem. Soc.* **1980**, *102*, 7808.

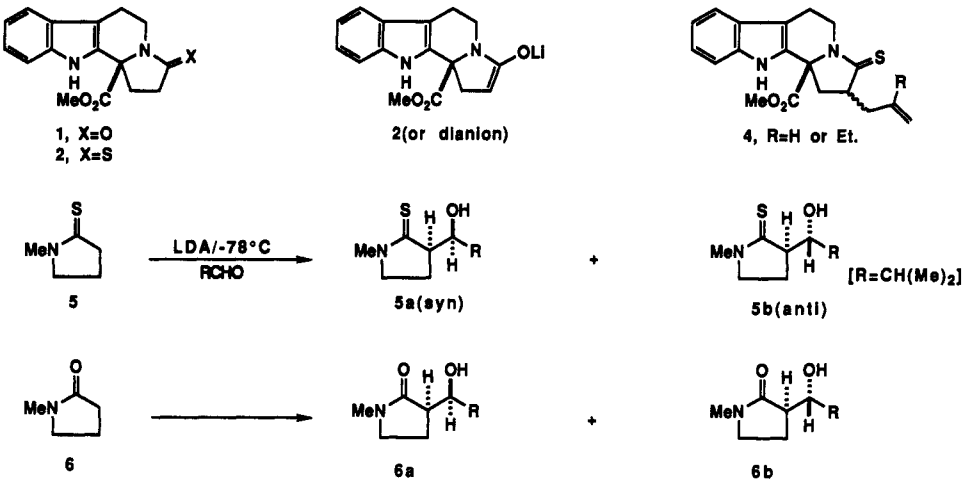
(6) Johnson, F. *Chem. Rev.* **1968**, *68*, 375. Hoffmann, R. W. *Chem. Rev.* **1989**, *89*, 1841.

(7) Zimmerman, H. E.; Traxler, M. D. *J. Am. Chem. Soc.* **1957**, *79*, 1920.

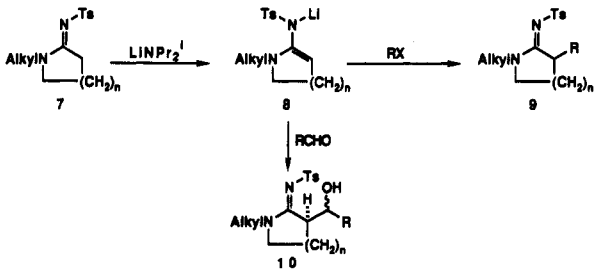
(8) King, C. *J. Org. Chem.* **1960**, *25*, 352.

0022-3263/91/1956-1529$02.50/0

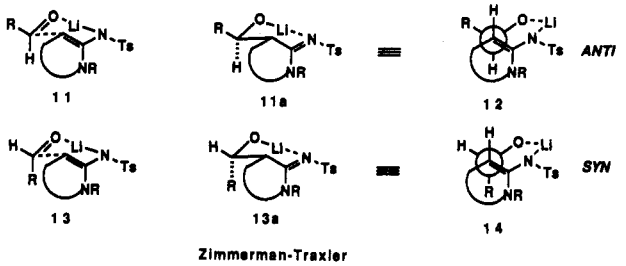
Scheme I



Scheme II

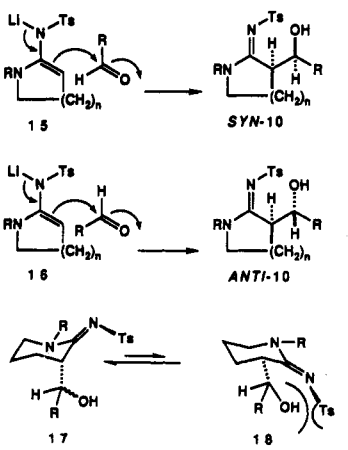


Scheme III



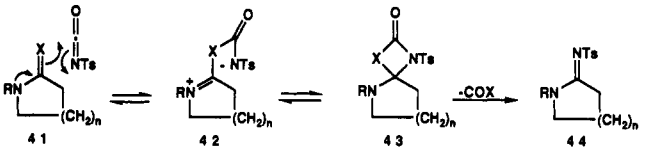
Zimmerman-Traxler

Scheme IV

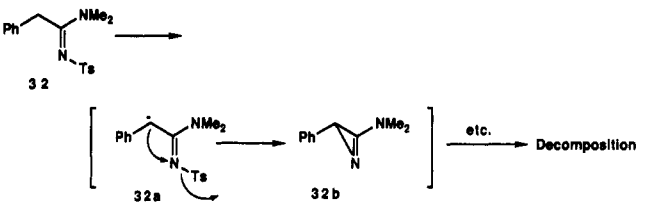


of amides with *p*-tolylsulfonyl isocyanate at room temperature gave the derived N^1-*p*-tolylsulfonyl amidines in excellent yields (ca. 90%) (Table I). While thioamides (entries 1, 2, 3, and 8) react more rapidly with *p*-tolylsulfonyl isocyanate, it offers no real advantages since they have to be made from the corresponding amide. In all cases the amidines **31** through **40** were isolated as a single stereoisomer, and on the basis of the X-ray data (for

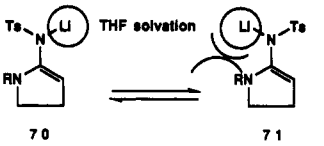
Scheme V



Scheme VI



Scheme VII



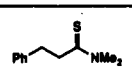
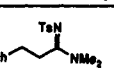
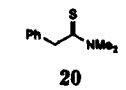
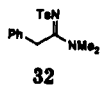
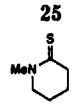
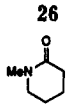
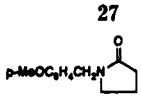
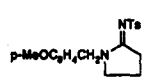
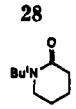
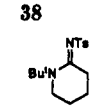
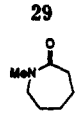
compounds **51**, **52**, and **65**) they are presumably the *E* geometrical isomers. Scheme V shows a plausible mechanism for the conversion of amides **41** (X = O) and thioamides **41** (X = S) into their corresponding NTs amidines **44** via the dipolar intermediate **42** and the extrusion of CO_2 or COS from **43**.

Before proceeding to examine the diastereoselectivity of the amidate anions derived from the amidines **33** through **40** in the aldol reaction, we investigated some simple alkylation reactions. Table II summarizes the results. The amidate anions derived from treatment of **32**/**33** and **37** with lithium diisopropylamide at −78 °C in tetrahydrofuran underwent clean monoalkylation. No dialkylation products could be detected. The amidate anion derived from the acyclic substrate **32** was not stable above approximately −20 °C. It has the potential to enter into Neber-type rearrangement chemistry, Scheme VI, and this may be the cause of its instability.[9]

Quenching of the amidate anions derived from the cyclic amidines with aldehydes at −78 °C gave high yields of the aldol adducts (Table III). Comparing the examples **5**/**6** (Scheme I) and the general tendency for *E* enolates (in cyclic systems) to give the anti aldol as the major product,

(9) O'Brien, C. *Chem. Rev.* **1964**, *64*, 81.

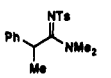
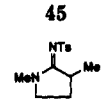
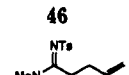
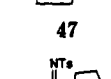
Table I

entry	substrate	conditions	NTs amidine	yield (%)
1	 19	TsNCO/20 °C/THF/2 h	 31	84%
2	 20	TsNCO/20 °C/THF/5 h	 32	80%
3	 21	TsNCO/20 °C/THF/5 h	 33	90%
4	 22	TsNCO/20 °C/THF/18 h	33	92%
5	 23	TsNCO/20 °C/THF/18 h	 34	91%
6	 24	TsNCO/20 °C/THF/18 h	 35	89%
7	 25	TsNCO/20 °C/THF/18 h	 36	91%
8	 26	TsNCO/20 °C/THF/5 h	 37	91%
9	 27	TsNCO/20 °C/THF/18 h	37	84%
10	 28	TsNCO/20 °C/THF/2 h	 38	90%
11	 29	TsNCO/20 °C/THF/5 h	 39	79%
12	 30	TsNCO/20 °C/THF/5 h	 40	83%

the contrast is substantial. Entries 1 and 2 show that the major diastereomer is the syn adduct. The relative stereochemistry of **51** and **52** was determined by single-crystal X-ray crystallography.[10] The vicinal methine ^{1}H coupling in the syn diastereomers (**49**, **51**, **55**, **57**, **59**, and **61**) is in the range of 9.0–9.9 Hz, and for the anti diastereomers (**52**, **56**, **58**, **60**, and **62**) this coupling is smaller, 4.5–5.7 Hz. Increasing the steric bulk of the N^1-alkyl group from Me (entry 1, syn:anti 86:14), Et (entry 5, syn:anti 64:36), *i*-Pr (entry 6, syn:anti 57:43), through to *t*-Bu (entry 7, syn:anti, 50:50) in the pyrrolidine series of compounds could be interpreted as changing the rotamer population, **70** versus **71** (Scheme VII). The predominance of the syn isomer in the aldol reaction of **33** (entry 1, Table III) is ascribed to the reaction of the anion via an open transition state involving the rotamer **71**, rather than **70**.

The rotamer **71** can react with an aldehyde in an open transition state to give the syn adducts (Scheme IV), whereas the rotamer **70** can adopt a Zimmerman–Traxler-type transition state that would lead to the anti adducts. The lithium atom is solvated by the tetrahydrofuran and should be bulkier than the *p*-tolylsulfonyl group.[11] Therefore as the size of the N^1-alkyl group increases (Me → Et → *i*-Pr → *t*-Bu) so does the $A^{1,3}$ steric interaction between Li–THF$_n$. This will favor the rotamer **70** and give increased amounts of the anti adducts. The same effect was seen in the piperidine series. Treatment of the anion derived from **37** (entry 10) with benzaldehyde gave only the syn adduct **65**, whereas the *t*-BuN analogue **39** (entry 11) gave both the syn and anti adducts, **66**/**67** (1:1). The stereochemistry of **65** was established by single-crystal X-ray crystallography, and also clearly shows that the newly formed carbon–carbon bond is axial (see **17**/**18**).[10] The only electrophiles we have examined other than benzaldehyde are *t*-BuCHO and PhCOMe (entries 3 and 4, Table III), and in both cases a single diastereomer was isolated (**53** and **54** respectively).

Table II

entry	substrate	conditions	product	yield (%)
1	32	LDA/−78 to 0 °C/THF/MeI	 45	62%
2	33	LDA/−78 to 0 °C/THF/MeI	 46	70%
3	33	LDA/−78 to 0 °C/THF/H_2C=$CHCH_2Br$	 47	90%
4	37	LDA/−78 °C/THF/Br-$(CH_2)_4Br$	 48	60%

Experimental Section

General procedure for the synthesis of *N*-(4-methylphenyl)-sulfonyl amidines **31** through **40**.

p-Tolylsulfonyl isocyanate (1.0 equiv) was slowly added dropwise to a solution of the amide or thioamide (1.0 equiv) in tetrahydrofuran at 0 °C. The mixture was warmed to 20 °C, stirred for 16–30 h, and cooled to 0 °C to cause the direct crystallization of the amidines. In some cases crystallization was difficult; therefore, the solvent was evaporated in vacuo and the residue triturated with ether/pentane (1:1) or chromatographed over silica gel, eluting with ethyl acetate/hexane (1:1) to give the *N*-(4-methylphenyl)sulfonyl amidines.

3-Phenyl-1-(((4-methylphenyl)sulfonyl)imino)-*N*,*N*-dimethylpropylamine (31): mp 109–110 °C (from hexane/CH_2Cl_2); ^{1}H NMR (300 MHz, $CDCl_3$) δ 2.39 (3 H, s), 3.00 (3 H, s), 3.04 (3 H, s), 3.05–3.01 (2 H, m), 3.24–3.17 (2 H, m), 7.25 (2 H, d, J = 7.8 Hz), 7.30 (5 H, m), 7.87 (2 H, d, J = 7.8 Hz). Anal. Calcd for $C_{18}H_{22}N_2O_2S$: C, 65.43; H, 6.71; N, 8.48. Found: C, 65.33; H, 6.75; N, 8.30.

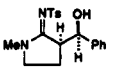
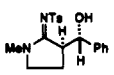
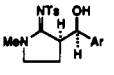
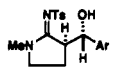
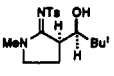
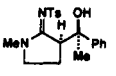
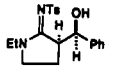
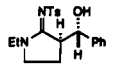
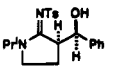
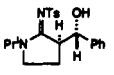
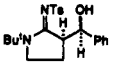
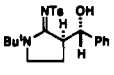
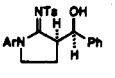
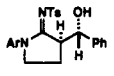
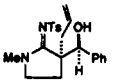
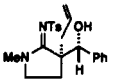
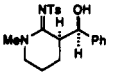
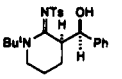
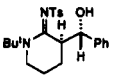
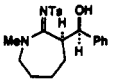
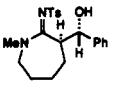
2-Phenyl-1-(((4-methylphenyl)sulfonyl)imino)-*N*,*N*-dimethylethylamine (32): mp 124–125 °C (from hexane/CH_2Cl_2); ^{1}H NMR (300 MHz, $CDCl_3$) δ 2.32 (3 H, s), 2.82 (3 H, s), 3.05 (3 H, s), 4.40 (2 H, s), 7.20 (5 H, m), 7.26 (2 H, d, J = 7.8 Hz), 7.85 (2 H, d, J = 7.8 Hz). Anal. Calcd for $C_{17}H_{20}N_2O_2S$: C, 64.55; H, 6.33; N, 8.86. Found: C, 64.50; H, 6.20; N, 8.71.

1-Methyl-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (33). Typical Example. *p*-Tolylsulfonyl isocyanate (9.13 mL, 0.06 mol) and 1-methylpyrrolidin-2-one (5.75 mL, 0.06 mol) in

(10) The complete details of the crystallographic data for **51**, **52**, and **65** are given in the supplemental material. Dr. John C. Huffman, Molecular Structure Center, Indiana University, IN 47405, is thanked for the X-ray analyses.

(11) Laube, T.; Dunitz, J. D.; Seebach, D. *Helv. Chim. Acta* **1985**, *68*, 1373. Seebach, D. *Angew. Chem., Int. Ed.* **1988**, *27*, 1624. Willard, P. G.; Hintze, M. J. *J. Am. Chem. Soc.* **1987**, *109*, 5539.

Table III[a]

entry	substrate	reagent	products (syn/anti)	ratio (^{1}H NMR/HPLC)	yield (%)
1	**33**	PhCHO	 **49**  **50**	86:14/82:18	88%
2	**33**	4-MeOC$_6$H$_4$CHO	 **51**  **52**	88:12/87:13	87%
3	**33**	Bu/CHO	 **53**	100:0/100:0	86%
4	**33**	PhCOMe	 **54**	100:0/100:0	91%
5	**34**	PhCHO	 **55**  **56**	64:36/76:33	90%
6	**35**	PhCHO	 **57**  **58**	54:43/55:45	84%
7	**36**	PhCHO	 **59**  **60**	50:50/48:52	81%
8	**38**	PhCHO	 **61**  **62**	68:32/68:32	69%
9	**47**	PhCHO	 **63**  **64**	50:50/56:44	68%
10	**37**	PhCHO	 **65**	100:0/100:0	82%
11	**39**	PhCHO	 **66**  **67**	50:50/48:52	84%
12	**40**	PhCHO	 **68**  **69**	68:32/67:33	77%

[a] Yields refer to material after purification by chromatography. The ratios were measured before chromatography. Ar = 4-MeOC$_6$H$_4$CH$_2$.

dry tetrahydrofuran (15 mL) at 20 °C were stirred together for 18 h. Evaporation of the solvent in vacuo and crystallization of the residue from dichloromethane/*n*-hexane (1:1) gave **33** (13.6 g 92%): mp 163–164 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 2.08 (2 H, dt, J's = 8.4 and 7.8 Hz), 2.43 (3 H, s), 3.00 (3 H, s), 3.10 (2 H, t, J = 8.4 Hz), 3.49 (2 H, t, J = 7.8 Hz), 7.29 (2 H, d, J = 8.1 Hz), 7.85 (2 H, d, J = 8.1 Hz); IR ($CHCl_3$) 1600 cm^{-1}. Anal. Calcd for $C_{12}H_{16}N_2O_2S$: C, 57.14; H, 6.35; N, 11.11. Found: C, 57.07; H, 6.21; N, 10.98. Similarly the thioamide **21** gave **33** in 90% yield.

1-Ethyl-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (34): mp 107–108 °C ($CHCl_3$/hexane) ^{1}H NMR (300 MHz, $CDCl_3$) δ 1.10 (3 H, t, J = 7.8 Hz), 2.01 (2 H, m), 2.37 (3 H, s), 3.00 (2 H, t, J = 7.5 Hz), 3.40–3.47 (5 H, m), 7.28 (2 H, d, J = 7.8 Hz), 7.78 (2 H, d, J = 7.8 Hz); IR ($CHCl_3$) 1580 and 1140 cm^{-1}. Anal. Calcd for $C_{14}H_{20}N_2O_2S$: C, 59.97; H, 7.19; N, 10.00. Found: C, 59.71; H, 7.14; N, 9.76.

1-Isopropyl-2-(((4-methylphenyl)sulfonyl)imino)-pyrrolidine (35): mp 90–91 °C ($CHCl_3$/hexane); ^{1}H NMR (300 MHz, $CDCl_3$) δ 1.13 (6 H, d, J = 7.5 Hz), 2.00 (2 H, quintet, J = 7.5 Hz), 2.39 (3 H, s), 3.03 (2 H, t, J = 7.5 Hz), 3.38 (2 H, t, J = 7.5 Hz), 4.55 (1 H, m), 7.24 (2 H, d, J = 9.0 Hz), 7.80 (2 H, d, J = 9.0 Hz); IR ($CHCl_3$) 1580 and 1140 cm^{-1}. Anal. Calcd for $C_{14}H_{20}N_2O_2S$: C, 59.97; H, 7.19; N, 10.00. Found: C, 59.71; H, 7.14; N, 9.76.

1-*tert*-Butyl-2-(((4-methylphenyl)sulfonyl)imino)-pyrrolidine (36): mp 91–92 °C ($CHCl_3$/hexane); ^{1}H NMR (300 MHz, $CDCl_3$) δ 1.14 (9 H, s), 1.87–1.98 (2 H, m), 2.38 (3 H, s), 3.07 (2 H, t, J = 8.1 Hz), 3.53 (2 H, t, J = 6.9 Hz), 7.23 (2 H, d, J = 9 Hz), 7.78 (2 H, d, J = 9 Hz). Anal. Calcd for $C_{15}H_{22}N_2O_2S$: C, 61.19; H, 7.54; N, 9.52. Found: C, 61.25; H, 7.67; N, 9.55.

1-Methyl-2-(((4-methylphenyl)sulfonyl)imino)piperidine (37): mp 109–110 °C ($CHCl_3$/hexane); ^{1}H NMR (300 MHz, $CDCl_3$) δ 1.75–1.79 (4 H, m), 2.39 (3 H, s), 3.02 (3 H, s), 3.04 (2 H, t, J = 6.3 Hz), 3.34 (2 H, t, J = 5.7 Hz), 7.24 (2 H, d, J = 8.4 Hz), 7.82 (2 H, d, J = 8.4 Hz). Anal. Calcd for $C_{13}H_{18}N_2O_2S$: C, 58.62; H, 6.81; N, 10.52. Found: C, 58.37; H, 6.63; N, 10.27.

1-(4-Methoxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (38): mp 139–140 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.93–2.04 (2 H, m), 2.41 (3 H, s), 3.08 (2 H, t, J = 8.1 Hz), 3.32 (2 H, t, J = 7.2 Hz), 3.79 (3 H, s), 4.52 (2 H, s), 6.82 (2 H, d, J = 8.4 Hz), 7.14 (2 H, d, J = 8.4 Hz), 7.26 (2 H, d, J = 8.1 Hz), 7.83 (2 H, d, J = 8.1 Hz). Anal. Calcd for $C_{19}H_{22}N_2O_3S$: C, 63.66; H, 6.19; N, 7.82. Found: C, 63.42; H, 5.90; N, 7.55.

1-*tert*-Butyl-2-(((4-methylphenyl)sulfonyl)imino)-piperidine (39): mp 81–83 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.43 (9 H, s), 1.61–1.81 (4 H, m), 2.40 (3 H, s), 3.13 (2 H, t, J = 6.3 Hz), 3.38 (2 H, t, J = 6.0 Hz), 7.25 (2 H, d, J = 7.8 Hz), 7.80 (2 H, d, J = 7.8 Hz). Anal. Calcd for $C_{16}H_{24}N_2O_2S$: C, 62.31; H, 7.85; N, 9.09. Found: C, 62.64; H, 8.08; N, 9.24.

1-Methyl-2-(((4-methylphenyl)sulfonyl)imino)hexahydroazepine (40): mp 109–111 °C (ether/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.61–1.72 (6 H, m), 2.39 (3 H, s), 3.09 (3 H, s), 3.12–3.14 (2 H, m), 3.46–3.50 (2 H, m), 7.25 (2 H, d, J = 10.2 Hz), 7.83 (2 H, d, J = 10.2 Hz). Anal. Calcd for $C_{14}H_{20}N_2O_2S$: C, 59.97; H, 7.19; N, 10.00. Found: C, 60.13; H, 7.37; N, 10.14.

General Procedure for the Preparation of ((4-Methylphenyl)sulfonyl)imino *N*,*N*-Dialkyl Anions and Their Quenching with Alkylation Reagents and Carbonyl Compounds. A solution of lithium diisopropylamide in tetrahydrofuran (0.71 M, 2.0 mL, 1.42 mmol) at −78 °C was added dropwise to a solution of the amidine (1.0 mmol) in tetrahydrofuran (10–15 mL) at −78 °C. The mixture was stirred at −78 °C for 0.5 h and the electrophile (2 mmol) added. The resulting solution was stirred until thin layer chromatography (SiO_2, ethyl acetate) indicated complete consumption of the starting amidine (10 to 120 min). Water (10 mL) was added to the reaction mixture (at −78 °C) and the resulting slurry warmed to room temperature (ca. 25 °C). The solution was extracted with diethyl ether (3 × 10 mL), and the combined extracts were washed with saturated brine and dried ($MgSO_4$). Evaporation of the extract in vacuo gave the products, which were purified by direct crystallization or chromatography over silica gel, eluting with ethyl acetate–hexane. Diastereomer ratios were determined by ^1H NMR (300 MHz, $CDCl_3$) and analytical HPLC analysis of the crude unfractionated material prior to purification.

2-Phenyl-1-(((4-methylphenyl)sulfonyl)imino)-*N*,*N*-dimethylpropylamine (45): mp 159–160 °C (hexane/CH_2Cl_2); ^1H NMR (90 MHz, $CDCl_3$) δ 1.57 (3 H, d, J = 7.0 Hz), 2.35 (3 H, s), 2.70 (3 H, b), 2.90 (3 H, b), 5.48 (2 H, q, J = 7.0 Hz), 7.20 (7 H, b), 7.85 (2 H, d, J = 9.0 Hz). Anal. Calcd for $C_{18}H_{22}N_2O_2S$: C, 65.45; H, 6.67; N, 8.48. Found: C, 65.60; H, 6.60; N, 8.30.

1,3-Dimethyl-2-(((4-methylphenyl)sulfonyl)imino)-pyrrolidine (46): mp 75–76 °C (hexane/CH_2Cl_2); ^1H NMR (300 MHz, $CDCl_3$) δ 1.35 (3 H, d, J = 7.8 Hz), 2.39 (3 H, s), 2.94 (3 H, s), 3.33 (1 H, dt, J's = 9.9 and 1.2 Hz), 3.59 (1 H, m), 3.75 (1 H, dt, J's = 7.8 and 7.5 Hz), 7.42 (2 H, d, J = 7.8 Hz), 7.83 (2 H, d, J = 7.8 Hz). Anal. Calcd for $C_{13}H_{18}N_2O_2S$: C, 58.62; H, 6.81; N, 10.52. Found: C, 58.40; H, 6.61; N, 10.48.

1-Methyl-3-allyl-2-(((4-methylphenyl)sulfonyl)imino)-pyrrolidine (47): mp 76–77 °C (hexane/CH_2Cl_2); ^1H NMR (300 MHz, $CDCl_3$) δ 1.85–1.94 (1 H, m), 2.00–2.16 (1 H, m), 2.20–2.30 (1 H, m), 2.36 (3 H, s), 2.62–2.64 (1 H, m), 2.90 (3 H, s), 3.29 (1 H, dt, J's = 13 and 2 Hz), 3.34–3.53 (1 H, m), 3.70 (1 H, dt, J's = 11 and 3 hz), 5.03–5.09 (2 H, m), 5.66–5.80 (1 H, m), 7.21 (2 H, d, J = 10 Hz), 7.80 (2 H, d, J = 10 Hz). Anal. Calcd for $C_{15}H_{20}H_2O_2S$: C, 61.62; H, 6.89; N, 9.58. Found: C, 61.53; H, 6.81; N, 9.68.

1-Methyl-3,3-tetramethylene-2-(((4-methylphenyl)-sulfonyl)imino)piperidine (48): mp 144–145 °C (hexane/$CHCl_3$); ^1H NMR (300 MHz, $CDCl_3$) δ 1.40–1.60 (8 H, m), 1.60–1.68 (2 H, m), 1.76–1.86 (2 H, m), 2.14–2.26 (2 H, m), 2.38 (3 H, s), 3.45 (3 H, s), 7.20 (2 H, d, J = 7.8 Hz), 6.80 (2 H, d, J = 7.8 Hz). Anal. Calcd for $C_{17}H_{24}N_2O_2S$: C, 63.72; H, 7.55; N, 8.74. Found: C, 63.66; H, 7.45; N, 8.60.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (49)**: mp 178–179 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.71–1.89 (1 H, m), 2.05–2.16 (1 H, m), 2.39 (3 H, s), 2.87 (1 H, bs), 2.98 (3 H, s), 3.24 (1 H, ddd, J's = 9.6, 8.7, and 1.2 Hz), 3.65 (1 H, q, J = 8.7 Hz), 3.98 (1 H, d, J = 9.6 Hz), 5.93 (1 H, s), 7.22–7.28 (3 H, m), 7.36 (2 H, dd, J's = 7.8 and 7.5 Hz), 7.55 (2 H, d, J = 8.1 Hz), 7.86 (2 H, d, J = 8.1 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ 19.99 (t), 21.41 (q), 32.31 (q), 50.63 (d), 51.93 (t), 73.54 (d), 125.54 (d), 126.05 (d), 127.01 (d), 128.21 (d), 129.08 (d), 141.32 (s), 141.78 (s), 142.44 (s), 169.35 (s); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{19}H_{22}N_2O_3S$: C, 63.94; H, 6.19; N, 7.82. Found: C, 63.78; H, 6.20; N, 7.70.

***rel*-(3*S*,1′*S*) diastereomer 50**: mp 169–170 °C ($CHCl_3$/hexane); HRMS calcd for $C_{19}H_{22}N_2O_3S$ 358.1251, found m/e 358.1321.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1′-hydroxy-4′-methoxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (51)**: mp 166–167 °C ($CHCl_3$/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.78–1.83 (1 H, m), 1.91–2.03 (1 H, m), 2.40 (3 H, s), 2.78 (1 H, bs), 2.98 (3 H, s), 3.24 (1 H, ddd, J's = 9.8, 9.3, and 1.4 Hz), 3.61 (1 H, q, J = 9.3 Hz), 3.81 (3 H, s), 3.94 (1 H, d, J = 9.8 Hz), 5.87 (1 H, s), 6.89 (2 H, d, J = 8.4 Hz), 7.24 (2 H, d, J = 9.0 Hz), 7.45 (2 H, d, J = 9.0 Hz), 7.87 (2 H, d, J = 8.4 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{20}H_{24}N_2O_4S$: C, 61.83; H, 6.23; N, 7.22. Found: C, 61.69; H, 6.40; H, 7.14.

***rel*-(3*S*,1′*S*) diastereomer 52**: mp 199–200 °C ($CHCl_3$/pentane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.98–2.09 (1 H, m), 2.14–2.20 (1 H, m), 2.32–2.44 (1 H, m), 2.40 (3 H, s), 2.74 (3 H, s), 2.97 (1 H, t, J = 9.0 Hz), 3.09 (1 H, d, J = 4.5 Hz), 3.79 (3 H, s), 4.10 (1 H, t, J = 4.5 Hz), 5.48 (1 H, bs), 6.48 (2 H, d, J = 9.0 Hz), 7.27 (2 H, d, J = 7.5 Hz), 7.32 (2 H, d, J = 7.5 Hz), 7.89 (2 H, d, J = 9.0 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{20}H_{24}N_2O_4S$: C, 61.83; H, 6.23; N, 7.22. Found: C, 61.56; H, 6.40; N, 7.32.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1′-hydroxy-2′,2′-dimethylpropyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (53)**: mp 161–162 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.05 (9 H, s), 1.94 (1 H, dd, J's = 12.9 and 5.7 Hz), 2.19–2.24 (1 H, m), 2.40 (3 H, s), 2.96 (3 H, s), 3.25–3.31 (2 H, m), 3.68–3.81 (2 H, m), 7.26 (2 H, d, J = 7.8 Hz), 7.83 (2 H, d, J = 7.8 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{17}H_{26}N_2O_3S$: C, 60.33; H, 775; N, 8.38. Found: C, 59.99; H, 7.95; N, 8.23.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1′-hydroxy-1′-methylbenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (54)**: mp 184–185 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.81–1.93 (1 H, m), 1.84 (3 H, s), 2.00–2.11 (1 H, m), 2.41 (3 H, s), 2.71–2.78 (2 H, m), 2.77 (3 H, s), 4.00 (1 H, d, J = 9.3 Hz), 4.70 (1 H, s), 7.26–7.30 (5 H, m), 7.45–7.48 (2 H, m), 7.88 (2 H, d, J = 8.1 Hz). Anal. Calcd for $C_{20}H_{24}N_2O_3S$: C, 64.49; H, 6.50; N, 7.53. Found: C, 64.14; H, 6.25; N, 7.74.

***rel*-(3*S*, 1′*R*)-1-Ethyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (55)**: mp 158–159 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.13 (3 H, t, J = 7.8 Hz), 1.73–1.88 (1 H, m), 2.05–2.13 (1 H, m), 2.40 (3 H, s), 2.50 (1 H, bs), 3.26 (1 H, ddd, J's = 2.3, 9.3, and 2.4 Hz), 3.36–3.46 (1 H, m), 3.48–3.59 (1 H, m), 3.65 (2 H, q, J = 7.8 Hz), 3.99 (1 H, d, J = 9.6 Hz), 5.93 (1 H, s), 7.24–7.28 (3 H, m), 7.36 (2 H, dd, J's = 7.2 Hz), 7.54 (2 H, d, J = 7.2 Hz), 7.87 (2 H, d, J = 8.4 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{20}H_{24}N_3O_3S$: C, 64.49; H, 6.50; N, 7.53. Found: C, 64.37; H, 6.51; N, 7.62.

***rel*-(3*S*,1′*S*) diastereomer 56**: mp 139–140 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 0.85 (3 H, t, J = 6.6 Hz), 1.95–2.09 (1 H, m), 2.22–2.38 (1 H, m), 2.40 (3 H, s), 2.95 (1 H, dd, J = 9.9 and 9.6 Hz), 3.09–3.19 (1 H, m), 3.21–3.37 (3 H, m), 4.15 (1 H, dd, J = 9.0 and 4.5 Hz), 5.58 (1 H, d, J = 5.1 Hz), 7.25–7.29 (5 H, m), 7.43 (2 H, dd, J = 6.9 and 2.4 Hz), 7.88 (2 H, d, J = 9 Hz); IR ($CHCl_3$) 3300 and 1602 cm^{-1}. Anal. Calcd for $C_{20}H_{24}N_2O_3S$: C, 64.49; H, 6.50; N, 7.53. Found: C, 64.42; H, 6.58; N, 7.69.

***rel*-(3*S*,1′*R*)-1-Isopropyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (57)**: mp 185–186 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.11 (3 H, d, J = 6.6 Hz), 1.18 (3 H, d, J = 6.6 Hz), 1.67 (1 H, bs), 1.72–1.81 (1 H, m), 2.05–2.18 (1 H, m), 2.40 (3 H, s), 3.27 (1 H, ddd, J = 10.5, 9.3, and 1.8 Hz), 3.53 (1 H, q, J = 9.0 Hz), 4.01 (1 H, d, J = 9.9 Hz), 4.55 (1 H, s, J = 6.6 Hz), 5.93 (1 H, s), 7.25–7.29 (3 H, m), 7.37 (2 H, t, J = 7.8 Hz), 7.54 (2 H, d, J = 7.5 Hz), 7.87 (2 H, d, J = 8.1 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{21}H_{26}N_2O_3S$: C, 65.26; H, 6.79; N, 7.25. Found: C, 65.26; H, 6.68; N, 7.14.

***rel*-(3*S*,1′*S*) diastereomer 58**: mp 161–163 °C. Anal. Calcd for $C_{21}H_{26}N_2O_3S$: C, 65.26; H, 6.79; N, 7.25. Found: C, 65.08; H, 6.76; N, 7.44.

***rel*-(3*S*,1′*R*)-1-*tert*-Butyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (59)**: mp 187–188 °C (CH_2Cl_2/hexane): ^1H NMR (300 MHz, $CDCl_3$) δ 1.41 (9 H, s), 1.68–1.76 (1 H, m), 1.93–2.01 (1 H, m), 2.32 (1 H, m), 2.39 (3 H, s), 3.43 (1 H, ddd, *J* = 10.8, 9.3, and 2.4 Hz), 3.67 (1 H, q, *J* = 9.0 Hz), 4.02 (1 H, ddd, *J* = 10.5 Hz), 5.95 (1 H, bs), 7.22–7.26 (3 H, m), 7.35 (2 H, ddd, *J*'s = 8.1, 5.4, and 2.7 Hz), 7.54 (2 H, d, *J* = 8.4 Hz), 7.84 (2 H, ddd, *J*'s = 8.4 and 2.7 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{22}H_{28}N_2O_3S$: C, 65.97; H, 7.05; N, 7.00. Found: C, 65.71; H, 7.22; N, 6.83.

***rel*-(3*S*,1′*S*) diastereomer 60**: mp 125–126 °C ($CHCl_3$/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.24 (9 H, s), 1.41 (1 H, m), 1.93–2.04 (1 H, m), 2.11–2.18 (1 H, m), 2.41 (3 H, s), 2.51–2.60 (1 H, m), 3.23 (1 H, dd, *J*'s = 11.1 and 9.9 Hz), 4.17 (1 H, dd, *J*'s = 9.0 and 5.7 Hz), 5.49 (1 H, d, *J* = 5.4 Hz), 7.26–7.32 (5 H, m), 7.48 (2 H, dd, *J*'s = 7.8 and 1.2 Hz), 7.87 (1 H, d, *J* = 8.1 Hz); IR ($CHCl_3$) 3300 and 1600 cm^{-1}. Anal. Calcd for $C_{22}H_{28}N_2O_3S$: C, 65.97; H, 7.05; N, 7.00. Found: C, 65.58; H, 7.06; N, 6.69.

***rel*-(3*S*,1′*R*)-1-(4-Methoxybenzyl)-3-(1-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (61)**: colorless foam; ^1H NMR (300 MHz, $CDCl_3$) δ 1.68–1.79 (1 H, m), 2.03–2.10 (1 H, m), 2.40 (3 H, s), 2.75 (1 H, bs), 3.17 (1 H, ddd, *J*'s = 11.7, 10.5, and 1.2 Hz), 3.55 (1 H, q, *J* = 8.7 Hz), 3.77 (3 H, s), 4.04 (1 H, d, *J* = 9.3 Hz), 7.11 (2 H, d, *J* = 9.3 Hz), 7.24–7.28 (3 H, m), 7.35 (2 H, dd, *J*'s = 7.8 and 5.4 Hz), 7.55 (2 H, d, *J* = 7.8 Hz), 7.87 (2 H, d, *J* = 9.0 Hz); IR ($CHCl_3$) 3300 and 1604 cm^{-1}. Anal. Calcd for $C_{26}H_{28}N_2aO_4S$: C, 67.22; H, 6.09; N, 6.03. Found: C, 67.04; H, 5.89; N, 5.90.

***rel*-(3*S*,1′*S*) diastereomer 62**: colorless foam; ^1H NMR (300 MHz, $CDCl_3$) δ 1.51–2.05 (1 H, m), 2.13–2.31 (2 H, m), 2.42 (3 H, s), 2.88 (1 H, dd, *J*'s = 9.9 and 9.6 Hz), 3.50 (1 H, br), 3.77 (3 H, s), 4.05 and 4.51 (2 H, AB q, *J* = 14.4 Hz), 4.20 (1 H, dd, *J*'s = 5.7 and 5.4 Hz), 5.52 (1 H, d, *J* = 4.5 Hz), 6.73 (2 H, d, *J* = 8.7 Hz), 6.93 (2 H, d, *J* = 8.7 Hz), 7.22–7.29 (5 H, m), 7.40 (2 H, dd, *J*'s = 6.9 and 3.3 Hz). Anal. Calcd for $C_{26}H_{28}N_2O_4S$: C, 67.22; H, 6.09; N, 6.03. Found: C, 67.15; H, 5.98; N, 5.85.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1-hydroxybenzyl)-3-(2-propenyl)-2-(((4-methylphenyl)sulfonyl)imino)pyrrolidine (63)**: mp 153–154 °C ($CHCl_3$/pentane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.67–1.77 (1 H, m), 2.10–2.25 (2 H, m), 2.31 (1 H, dd, *J*'s = 13.5 and 9.0 Hz), 2.41 (3 H, s), 2.61–2.69 (1 H, m), 2.98 (1 H, dd, *J*'s = 13.5 and 5.7 Hz), 3.14 (3 H, s), 3.16–3.25 (1 H, m), 3.76 (1 H, bs), 5.08–5.18 (2 H, m), 5.66–5.87 (1 H, m), 7.26–7.30 (5 H, m), 7.41 (2 H, dd, *J*'s = 7.8 and 2.7 Hz), 7.89 (2 H, d, *J*'s = 8.1 Hz). Anal. Calcd for $C_{22}H_{26}N_2O_3S$: C, 66.30; H, 6.58; N, 7.03. Found: C, 66.23; H, 6.52; N, 7.20.

***rel*-(3*S*,1′*S*) diastereomer 64**: mp 125–125 °C ($CHCl_3$/pentane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.53–1.61 (1 H, ddd, *J*'s = 12.6, 8.1, and 4.2 Hz), 2.00–2.07 (1 H, m), 2.38–2.48 (1 H, m), 2.41 (3 H, s), 2.99–3.12 (2 H, m), 3.07 (3 H, s), 3.24–3.33 (1 H, m), 7.26–7.39 (7 H, m), 7.91 (2 H, d, *J* = 8.1 Hz). Anal. Calcd for $C_{22}H_{26}N_2O_3S$: C, 66.30; H, 6.58; N, 7.03. Found: C, 66.41; H, 6.68; N, 7.03.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)piperidine (65)**: mp 173–174 °C ($CHCl_3$/pentane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.32–1.43 (1 H, m), 1.52–1.61 (1 H, m), 1.68–1.78 (1 H, m), 2.21–2.31 (1 H, m), 2.40 (3 H, s), 2.55 (1 H, d, *J* = 4.2 Hz), 3.10 (3 H, s), 3.24–3.33 (1 H, m), 3.49–3.56 (1 H, m), 4.01–4.06 (1 H, m), 6.09 (1 H, t, *J* = 3.6 Hz), 7.22–7.28 (3 H, m), 7.36 (2 H, dd, *J*'s = 7.8 and 6.9 Hz), 7.59 (2 H, d, *J* = 7.5 Hz), 7.88 (2 H, d, *J* = 8.4 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ 166.86 (s), 142.14 (s), 141.34 (s), 128.93 (d), 128.04 (d), 126.89 (d), 125.77 (d), 125.67 (d), 75.00 (d), 51.16 (t), 44.03 (d), 39.25 (q), 21.33 (q), 20.21 (t), 19.71 (t); IR ($CHCl_3$) 3300 and 1570 cm^{-1}1. Anal. Calcd for $C_{20}H_{24}N_2O_3S$: C, 64.49; H, 6.50; N, 7.53. Found: C, 64.33; H, 6.74; N, 7.52.

***rel*-(3*S*,1′*R*)-1-*tert*-Butyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)piperidine (66)**: mp 209–210 °C (CH_2Cl_2/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.40 (9 H, s), 1.61–1.73 (2 H, m), 1.81–1.91 (1 H, m), 2.40 (3 H, s), 2.44–2.51 (1 H, m), 3.30 (1 H, ddd, *J*'s = 15.0, 11.4, and 3.6 Hz), 3.41–3.46 (1 H, m), 4.19 (1 H, ddd, *J*'s = 11.4, 8.7, and 2.7 Hz), 5.98 (1 H, dd, *J*'s = 3.6 and 3.3 Hz), 7.24–7.27 (3 H, m), 7.35 (2 H, dd, *J*'s = 7.8 and 7.8 Hz), 7.61 (2 H, d, *J* = 7.5 Hz), 7.84 (2 H, d, *J* = 8.4 Hz). Anal. Calcd for $C_{23}H_{30}N_2O_3S$: C, 66.03; H, 7.30; N, 6.76. Found: C, 66.48; H, 7.47; N, 6.53.

***rel*-(3*S*,1′*S*) diastereomer 67**: mp 178–179 °C ($CHCl_3$/hexane). Anal. Calcd for $C_{23}H_{30}N_2O_3S$: C, 66.03; H, 7.30; N, 6.76. Found: C, 66.61; H, 7.45; N, 6.90.

***rel*-(3*S*,1′*R*)-1-Methyl-3-(1′-hydroxybenzyl)-2-(((4-methylphenyl)sulfonyl)imino)hexahydroazepine (68)**: mp 156–157 °C (ether/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.19–1.37 (2 H, m), 1.41–1.56 (1 H, m), 1.59–1.63 (1 H, m), 1.71–1.81 (2 H, m), 2.39 (3 H, s), 3.01 (1 H, d, *J* = 3.3 Hz), 3.11 (1 H, ddd, *J*'s = 12.0, 8.1, and 3.9 Hz), 3.18 (3 H, s), 4.16 (1 H, dd, *J* = 8.7 and 1.2 Hz), 4.37 (1 H, ddd, *J*'s = 7.8, 3.9, and 3.9 Hz), 5.68 (1 H, s), 7.21–7.26 (3 H, m), 7.34 (2 H, dd, *J*'s = 7.8 and 6.9 Hz), 7.56 (2 H, d, *J* = 7.2 Hz), 7.84 (2 H, d, *J* = 8.1 Hz). Anal. Calcd for $C_{21}H_{26}N_2O_3S$: C, 65.26; H, 6.79; N, 7.25. Found: C, 64.92; H, 6.80; N, 7.36.

***rel*-(3*S*,1′*S*) diastereomer 69**: mp 170–171 °C (ether/hexane); ^1H NMR (300 MHz, $CDCl_3$) δ 1.21–1.31 (1 H, s), 1.52–1,87 (5 H, m), 2.41 (3 H, s), 3.16 (3 H, s), 3.37 (1 H, d, *J* = 15.3 Hz), 4.05 (1 H, ddd, *J*'s = 15.3, 13.2, and 2.1 Hz), 4.53–4.60 (1 H, m), 4.90–5.05 (2 H, m), 7.26–7.34 (3 H, m), 7.39 (2 H, dd, *J*'s = 7.2 and 7.2 Hz), 7.55 (2 H, d, *J* = 7.2 Hz), 7.88 (2 H, d, *J* = 8.1 Hz). Anal. Calcd for $C_{21}H_{26}N_2O_3S$: C, 65.26; H, 6.79; N, 7.25. Found: C, 64.89; H, 6.88; N, 6.97.

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Supplementary Material Available: Crystallographic data and ORTEP drawings for **51**, **52**, and **65** (39 pages). Ordering information is given on any current masthead page.